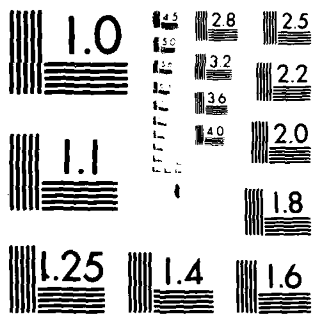
AD-A111 997 MCDONNELL DOUGLAS ASTRONAUTICS CO HUNTINGTON BEACH CA F/G 20/4
AERODYNAMIC COMPUTER CODE FOR ANALYZING HEAT TRANSFER AND PRESS--ETC(U)
MAR 82 K K WANG, R H WEATHERFORD N60921-80-C-0259
UNCLASSIFIED MDC-H0006 NL

1 OF 1
AD
A111997

END
DATE
FILMED
4-82
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

(12)

MDC H0006

ADA111997

AERODYNAMIC COMPUTER CODE FOR ANALYZING HEAT TRANSFER AND PRESSURE LOADS ON MISSILES

Prepared by Kenneth K. Wang
R. H. Weatherford

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
5301 BOLSA AVENUE
HUNTINGTON BEACH, CALIFORNIA 92647

MARCH 1982

FINAL REPORT
CONTRACT NUMBER N60921-80-C-0259
12 SEPTEMBER 1980 TO 11 MARCH 1982

Prepared for
NAVAL SURFACE WEAPONS CENTER
WHITE OAK, SILVER SPRING, MARYLAND 20910

This technical report has been reviewed and is approved.

P. C. Huang
Naval Surface Weapons Center

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A111 997	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) AERODYNAMIC COMPUTER CODE FOR ANALYZING HEAT TRANSFER AND PRESSURE LOADS ON MISSILES		5. TYPE OF REPORT & PERIOD COVERED Final Report, September 12, 1980 to March 11, 1982
		6. PERFORMING ORG. REPORT NUMBER MDC H0006
7. AUTHOR(s) Kenneth K. Wang and R. H. Weatherford		8. CONTRACT OR GRANT NUMBER(s) N60921-80-C-0259
9. PERFORMING ORGANIZATION NAME AND ADDRESS McDonnell Douglas Astronautics Company 5301 Bolsa Avenue Huntington Beach, California 92647		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Surface Weapons Center White Oak Silver Spring, Maryland 20910		12. REPORT DATE March 1982
		13. NUMBER OF PAGES 81
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

For public release, distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Aerodynamics
Pressure Distribution
Structural Analysis
Heat Transfer

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An aerodynamic computer code was developed for calculating the pressure distribution on a missile or its components, e.g., body and wings and subsequently interpolating the results by surface fit at locations as specified for structural analysis using the NASTRAN computer code. The code is valid from subsonic up to high supersonic speeds and for generalized attitudes of the missile. Subroutines have been added to the code to enable calculation of temperature histories, equilibrium temperature and heat flux at arbitrary locations on a missile. In addition capability for treating

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

slightly blunted nose configurations nas been incorporated.

PREFACE

This document reports the work performed by McDonnell Douglas Astronautics Company for the Naval Surface Weapons Center, White Oak Laboratory, Silver Spring, Maryland, for the development of an aerodynamic code for heat transfer analysis of a missile at high supersonic speed and nose pressure distribution of a missile with a slightly blunted nose.

For heat transfer calculations, the code has been modified to generate temperature history, equilibrium temperature and the rate of heat transfer at the locations specified by the output of the NSWC computer code PING and BING for stress analysis by NASTRAN. For a blunted nose, the code provides the pressure distribution at the specified locations also.

Theoretical background for the methods used in the development is described. For convenience, only a minimum of inputs have been added. Test cases for verification purposes are presented together with sample inputs to reduce the effort of preparation.

A complete listing is included.

CONTENTS

LIST OF SYMBOLS

C_F	local skin friction coefficient
c_p	specific heat
C_p	pressure coefficient, $2(p-p_\infty)/(\gamma\, p_\infty M_\infty^2)$
g_c	universal gravitation constant
h_c	heat transfer coefficient
M_δ	local Mach number
p	pressure
Pr	Prandtl number
p_t	total pressure
p_∞	free stream pressure
$\dot{q}$	heat transfer rate
r	recovery factor
Re_δ	local Reynolds number
T_R	recovery temperature
T_W	wall temperature
U_δ	local fluid velocity
γ	ratio of fluid specific heats
ε	infrared emittance of wall
θ	angle between the free stream velocity and the
n	surface normal
ρ	fluid density
σ	Stefan-Boltzmann constant

SUMMARY

This report represents the work performed under contract number N60921-80-C-0259 for the Naval Surface Weapons Center, White Oak Laboratory, Silver Spring, Maryland, under Naval Sea Systems Command Sponsorship for the development of an aerodynamic code for analyzing aerodynamic heating of a missile at high supersonic speeds and the pressure distribution on a slightly blunted nose.

For analyzing the aerodynamic heating of a missile, a number of subroutines have been added to the existing MDAC aerodynamic code. For missiles with a slightly blunted nose, additional calculations have been incorporated to provide the pressure distribution on the nose as required.

Section 1

INTRODUCTION

In 1979, a computer code for aerodynamic load analysis for a complete missile (Reference 1) was completed by McDonnell Douglas Astronautics Company (MDAC) under Contract N60921-78-C-0203 for the Naval Surface Weapons Center, White Oak Laboratory, Silver Spring, Maryland. It analyzes the complete missile or its components (wing or body) and provides pressure distributions at given locations, as specified by the outputs of NSWC computer code PING (Reference 2) or BING (Reference 3) on the missile surface.

For missile flight at high supersonic speeds ($2 \leq M_\infty \leq 6$) the problem of aerodynamic heating becomes important and needs to be analyzed. As an example, for an insulated flat plate aligned parallel to the flow, the surface temperature can reach anywhere from 1000°R to 3000°R for a speed range of $M_\infty = 2$ to 6. Thus, the induced thermal stress can seriously affect the structural integrity of the missile and failure of a missile component could result. Consequently, development of capability for analyzing the aerodynamic heating and the skin temperature of the missile is needed to complement the pressure load calculation. Furthermore, with the development of the code based on the linearized, small-disturbance equations of motion, the inability of the code to treat bodies with a slightly blunted nose also needs be remedied.

To accomplish these tasks, the code was substantially modified and new subroutines added. The principal effort consists of calculating additional flow field quantities, i.e., Mach number and temperature, at the specified locations and the pressure in the nose region. After much manipulation, the desired results of the computation, e.g., the temperature history, equilibrium

temperature, heat flux and nose pressure can be produced as punched output in the NASTRAN format or saved on tape (temperature history of element) as specified.

To minimize the development effort and for the user's convenience, the structure of the original code was retained to a large extent. Consequently, only a few additional input parameters are required for analyzing the aerodynamic heating or the pressure distribution on the blunt nose. For high supersonic cases ($M_\infty \leq 2.5$), the code is restricted in its application to a complete missile (body and wing) as was developed previously.

Section 2

AERODYNAMIC HEATING OF A MISSILE AT SUPERSONIC SPEEDS

At supersonic speeds, aerodynamic heat transfer can heat up the skin of an airplane or missile to temperatures at which the allowable strength of the skin is reduced. Several methods have been developed by different authors to account for aerodynamic heating effects at high speeds. Among these are Eckert (References 4, 5 and 6), Wilson (Reference 7), Van Driest (References 8, 9 and 10) and Spalding and Chi (Reference 11). Out of these, Eckert's reference temperature method was selected for incorporation into the aerodynamic computer code because of its reliability in predicting experimental heat transfer results and its compatibility with analyses used in the original MDAC/NSWC Aerodynamic Code.

Using Eckert's reference temperature method, net aerodynamic heat transfer to a missile skin is calculated from

$$\dot{q} = h_c (T_R - T_W) - \varepsilon\sigma T_W^4 \qquad (1)$$

The heat transfer coefficient, h_c, is calculated from

$$h_c = (C_f^*/2)(P_r)^{-2/3} \rho^* U_\delta \; c_p \; g_c \qquad (2)$$

$$= 4.851 \; C_f^* \rho^* U_\delta \qquad (2a)$$

The skin friction coefficient, C_f^*, is calculated as follows

$$C_f{}^* = C_{f_\ell}{}^* \qquad (R_{e_\delta} \leq 10^5) \tag{3a}$$

$$C_f{}^* = C_{f_t}{}^* \qquad (R_{e_\delta} > 10^6) \tag{3b}$$

$$C_f{}^* = C_{f_\ell}{}^* + (C_{f_t}^* - C_{f_\ell}{}^*)(\log_{10} R_{e_\delta} - 5) \tag{3c}$$

$$(10^5 < R_{e_\delta} \leq 10^6)$$

where

$$C_{f_\ell}{}^* = .664/(R_e{}^*/N_\ell)^{1/2} \tag{4}$$

and

$$C_{f_t}{}^* = .370/(\log_{10} (R_e{}^*/N_t))^{2.584} \tag{5}$$

Reference values, indicated by an asterisk (*) are evaluated at a reference temperature, which is given by

$$T^* = (T_\delta + T_W)/2 + .22r \frac{\gamma-1}{2} M_\delta^2 T_\delta \tag{6}$$

values for N_ℓ and N_t are

$$N_\ell = \begin{cases} 3 & \text{body of revolution} \\ 1 & \text{planar body (wing)} \end{cases} \tag{7}$$

$$N_t = \begin{cases} 2 & \text{body of revolution} \\ 1 & \text{planar body (wing)} \end{cases} \tag{8}$$

The governing differential equation from which the skin element temperatures and heat fluxes are calculated is

$$\rho_W c_p b \frac{dT_W}{dt} = h_c (T_R - T_W) - \varepsilon\sigma T_W^4 \tag{9}$$

The skin equilibrium temperature for each skin element is calculated from Equation (9) when the rate of change of temperature goes to zero

$$h_c (T_R - T_{eq}) = \varepsilon\sigma T_{eq}^4 \tag{10}$$

The temperature and heat flux for each skin element at time j are calculated from

$$T_j = T_{j-1} + [h_c(T_R - T_{j-1}) - \varepsilon\sigma T_{j-1}^4] \Delta t_j / \rho_W c_p b$$

and

$$q_j = h_c(T_R - T_j) - \varepsilon\sigma T_j^4$$

respectively.

Computation intervals are spaced closely together during early times and farther apart at later times so that precision will be retained during periods of rapid temperature rise but excessive computation time will not be required after the period of initial temperature rise. Temperatures and heat fluxes are printed at each tenth computation. Computation and print intervals are shown below

Time (sec)	Δt_j (sec)	Δt_{print} (sec)
0-2	0.05	0.5
2-6	0.10	1.0
6-10	0.20	2.0
10-50	0.50	5.0

Section 3

AERODYNAMIC PRESSURE OF A MISSILE WITH A SLIGHTLY BLUNTED NOSE

The MDAC/NSWC Aerodynamic Code as developed and modified in the past few years, is based on the linearized, small disturbance equations of motion. Consequently, its application is limited to sharp nose, streamlined bodies. However, it is recognized that for some missile configurations, a hemispherical nose is required for operational reasons. The aerodynamic characteristics of blunt nosed configurations can be considerably different from those of the sharp nosed geometry. In particular, the pressure distribution on the nose will greatly influence the aerodynamic coefficients. An appropriate assessment of the effect of the nose is needed.

To provide the capability for analyzing the nose pressure and thereby extending the ability of the aerodynamic code to bodies with a blunted nose, the code was modified based on the following approach.

In the subsonic/transonic case, the pressure distribution over a spherical nose is calculated from the Janzen-Rayleigh relation (Reference 17) for $M_\infty \lesssim 0.75$

$$C_p = 1 - \frac{9}{4}\sin^2\theta + \frac{M_\infty^{\ 2}}{4}\left(1 + \frac{3}{110}\sin^2\theta + \frac{1053}{352}\sin^4\theta\right) \tag{11}$$

and the empirical relation suggested in Reference 18 for $0.75 \lesssim M_\infty \lesssim 2.0$.

$$C_p(\theta) = C_{pmax}\cos^2\theta + F(\theta, M_\infty) \tag{12}$$

where

$$C_{pmax} = [(1 + \frac{\gamma-1}{2} M_\infty^{\ 2})^{\gamma/\gamma-1} - 1]/(\frac{\gamma}{2})\, M_\infty^{\ 2} \tag{13}$$

and

$$F(\theta, M_\infty) = \{0.78\, M_\infty^{-2.27} \cos\theta - 0.95 \exp[-2.235\,(M_\infty - 1)]\}\sin\theta \quad (14)$$

For supersonic flows, the modified Newtonian method as suggested by Lees (Reference 12) in a survey by Isaacson and Jones (Reference 13) is used.

$$C_p(\theta) = C_{pmax} \cos^2\theta \quad (15)$$

$$C_{pmax} = \left(\frac{P_t}{P_\infty} - 1\right)/\left(\frac{\gamma}{2} M_\infty^2\right) \quad (16)$$

$$\frac{P_t}{P_\infty} = \left[\frac{\gamma+1}{2} M_\infty^2\right]^{\frac{\gamma}{\gamma-1}} \left[\frac{\gamma+1}{2\gamma M_\infty^2 - (\gamma-1)}\right]^{\frac{1}{\gamma-1}} \quad (17)$$

In both cases, these expressions are valid only in the neighborhood of the nose region. Taking into consideration the basic assumptions of the analysis used in the code, the application of the nose pressure option must be limited to slender bodies with a slightly blunted nose. More precisely, the ratio of the nose radius to the body radius must not greatly exceed 0.1.

Section 4

COMPUTER PROGRAM

In 1979, under the contract number N60921-78-C-0203 from NSWC-WOL, the MDAC/NSWC Aerodynamic Code (Reference 1) was developed for calculating the aerodynamic pressure distribution over the missile traveling at high supersonic speeds and generalized attitudes. To extend further the capability of the code, it has been modified to include the aerodynamic heating at supersonic speeds. Additionally, analysis for the pressure distribution over a slightly blunted nose has also been incorporated.

As before, the code accepts as input the output of NSWC computer codes PING and BING which prescribe the finite element on the missile. The code generates as output the pressure distribution and heat transfer results for subsequent stress analysis by NASTRAN. At the user's option, both the pressure load and the equilibrium temperature may be produced as punched-card output in the NASTRAN format. For convenience, results of the aerodynamic heating analysis are saved on tape (TAPE 12) for future studies.

4.1 CODE CAPABILITIES AND RESTRICTIONS

Using appropriate input values, the code can be utilized to analyze a missile flying under a combination of the following conditions:

(a) Circular or near circular body

(b) Single or multiple wings

(c) Subsonic or supersonic speed ($M_\infty \lesssim 6.0$)*

(d) Small angle of attack, $\leq 10°$

(e) Small angle of yaw, $\leq 10°$

* For higher subsonic case ($M_\infty \geq 2.5$), code applies to complete missile only.

(f) Sharp or slightly blunted nose, $r_N/r_b \leq 0.1$

(g) Aerodynamic heating at supersonic speed

Although the small disturbance basis of the code generally excludes operation in the transonic regime, e.g., $0.8 < M_\infty < 1.2$, the blunt nose relations include an expression for pressure coefficient valid in this regime (Equation 12).

As a result of the basic assumptions used, some limitations on the use of the code need be noted. For a missile with a blunted nose, aerodynamic heating of the nose region represents an extremely complex phenomenon. The present approach selected for the heat transfer anaysis is valid only for analyzing the sharp nose case and should not be used for the blunt nose case.

The inputs specifying the missile dimensions and the free stream pressure must be consistent with each other. As an example, when the missile dimensions are given in inches, free stream pressure (PINF) must be in pounds per sq. in. However, in the case of heat transfer analysis, the missile dimension <u>must</u> be in inches and the free stream pressure in psi.

Based on the operating experience with the CDC CYBER 174 computer with the NOS system, the code requires a field length of 166,000 for execution. The computing time varies between one to three minutes for different cases.

4.2 INPUT DESCRIPTION

Several input parameters have been added to the input list (NAMELIST/UNIFID) for specifying either the heat transfer analysis or the pressure distribution analysis for a slightly blunted nose. The original input parameters retain

their function as explained in great detail in Reference 1 (pp. 9-16) and are repeated here for convenience.

XMACH	Mach number of flow. Higher supersonic routine employed when greater than 2.5, default value = 2.0.
PINF	Free stream pressure, default value = 14.7 psi.
DADEG	Incremental angle of attack of missile in degrees, default value = 0.
SID	Case identification number for each missile component (up to 20 allowed); default values have been set at 1. Also used for selecting the sign convention for pressure output. Code uses the accepted rule for pressure, i.e., positive acting toward the surface and negative acting away from the surface. For opposite-sign convention, set SID(L) as negative for pressure output on the desired component L (in the order of body, wing surfaces, upper or lower).
YAW	Angle of yaw in degrees with respect to the flow.
BROLL	Missile roll about body axis (degree).

The following input parameters are required for the case where missile body is included:

NBPFL	Number of body profile stations for specifying body geometry inputs $r = r(x)$; up to 51 stations allowed.
XB $\leq$ 51	Axial coordinate of body stations in the direction of flow for specifying the body profile.
RB $\leq$ 51	Radial coordinate of body profile at corresponding body stations.
ZD $\leq$ 51	Body camber at corresponding body stations.

ARB — Angle of attack of missile body in degrees, default value = 0.

In accordance with the overall organization of the code, the input parameters and data have been organized into two main groups in accordance with their assigned functions. The first group contains all the parameters needed for the specification of case selection, missile configuration, and flow conditions. They form the input parameter of the namelist UNIFID. The second group specifies the finite-element and grid-point system as generated by the NSWC computer codes BING and/or PING. It includes the specification for the coordinate system used for the finite elements.

For the convenience of the user, card format for inputs are described in their sequential order as required by the code.

A. Aerodynamic Control Parameters.

Card 1 Title and case description, format (20A4), alphanumeric.

Card 2 SUNIFID, begins at Column 2 with the symbol S.

Card 3 And additional cards if necessary, contain the following as input:

ICASE	= 1	Wing only.
	= 2	Body only.
	= 3	Complete missile.
NTRANS		Number of coordinate transformations required to convert the coordinates for the finite element to the coordinates used in the aerodynamic code. Two transformations are allowed for each missile component, in the following order; body, wings, and nacelles.

IPUNCH	= 0	No punched card output, default value.
	= 1	Punched card output requested.
IRW	= 2	Computation results are not saved on tape, default value.
	= 1	Aerodynamic computation results are saved on tape 12 for restart, first run only.
	= 2	Restart run, bypass all aerodynamic computations and begins computation at the start of pressure interpolation.
POLAR		Number of incremental angles of attack, default value = 0.

The following inputs are required for the case where the missile wing is included:

ISOLID	= 0	Wing of built-up construction, pressure load on both upper and lower wing surface generated, default value.
	= 1	Wing of solid section, sum of the pressure loads on wing surface generated.
IFORM	= 0	Wing of built-up construction, both upper and lower surface height (ZWI) are given at identical locations (XWI, YWI).
	= 1	Wing of built-up construction, upper and lower surface height (ZWI) are not given at identical locations.
	= 2	Flat wing surface.
NWPI		Number of coordinate points specify the wing surface contour ($\leq$30). Code allows a maximum of 20 wing surfaces (upper and lower). Each wing surface must be

defined in the form of equation of a surface, ZWI = f(XWI, YWI). A maximum of 30 points are permitted with the provision that the first four points are restricted to the specification of the corners of the wing only. The coordinates for the corners must be given in the following order. Starting with the innermost point of the leading edge, the remaining corners are to be given in a counter clockwise order viewing from the above.

NWING	Number of wings or tails. A maximum of 10 is allowed, default value = 0.
XWI(i, j), YWI(i, j), ZWI(i, j)	Wing-surface coordinates where indices i and j designate the surface coordinate point and wing surface, respectively.
DIHED	Dihedral angle, degrees.
PIVOT	Indicates dihedral, 0 for no dihedral, and >0 for dihedral present.
ARW	Angle of attack of wing in degrees, with respect to the body axis if complete missile is considered, default value = 0.

The following input parameters are required for the complete-missile case (ICASE = 3) except for high-supersonic-speed (M > 2.5) case:

NWPANL	Number of wings directly connected to the body.
XLG	Axial distance at the intersection of wing leading edge and body for each wing.

XTG	Axial distance at the intersection of wing trailing edge and body for each wing.
Card 4 SEND	Begin at column 2 the symbol S for ending input.

B. Finite-Element and Grid Inputs. The second group of input cards are arranged immediate following Card 4, as follows:

Cards 5 and 6	Coordinate-system specifications in the format of NASTRAN bulk-data deck [page 2.4-49 - 2.4-54, NASTRAN User's Manual, NAS SP-221(01), 1972]. Three position vectors -A, B, and C - are used to define the coordinate system. The first defines the origin, the second defines the Z axis, and the third defines a point in the XZ plane.

For Card 5 the following format is used:

Col 1-8	Coordinate system CORDJRbb for rectangular, CORDJCbb for cylindrical, CORDJSbb for spherical, where J identifies the coordinate system numbers.
Col 9-16	Coordinate identification number J, integer.
Col 17-24	Reference coordinate system, integer, optional
Col 25-32, 33-40, 41-48,	Components of vector A (3F8.2).
Col 49-56, 57-64, 65-72,	Components of vector B (3F8.2).

For Card 6: Col 1-8 blank.

Col 9-16, 17-24, 25-32, Components of vector C (3F8.2).

Cards 5 and 6 are to be repeated as many times as there are coordinate systems (NTRANS) required for specifying the finite element. They are to be arranged in the order of body and wings.

The finite element and grid specifications are arranged immediately following the coordinate-system input in the same order, i.e., body, wings.

Card 7: Specifies the number of grid cards (NGRIDP) and element cards (NE), Format (2I10).

The grid and the element cards as generated by the NSWC computer-code BING are sorted into two separate groups. They are then placed immediately after card 7 with the grid cards in front.

Some remarks regarding the input parparation need to be made here to facilitate the use of the aero code.

For the body-only case, inputs of the body profiles, expressed as $r = r(x)$, for aero-panel generation must be in the aero-coordinate system. It is required that x be the axial distance from the tip and r the radius of the body cross section (Figure 4-1). For the finite element and grid point, their

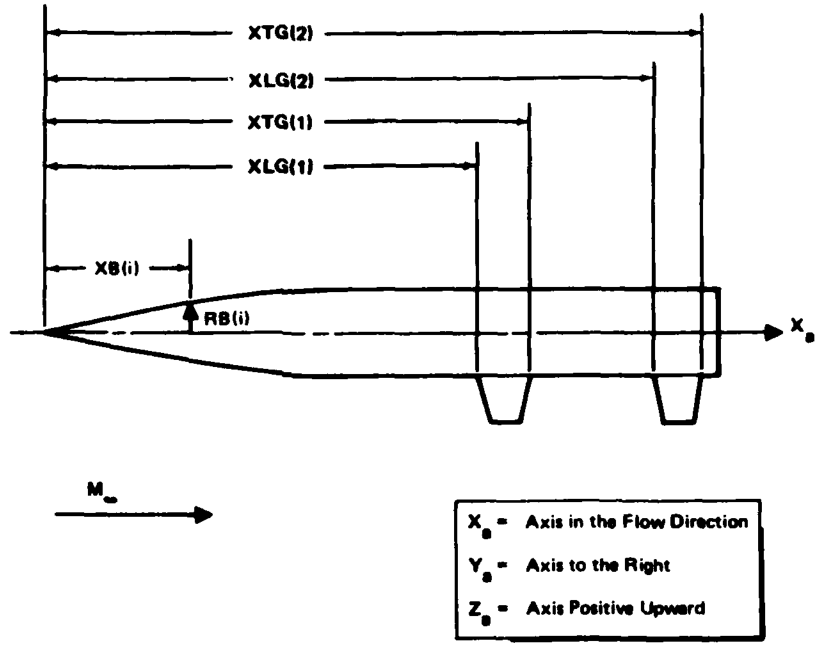


Figure 4-1. Body Profile Input

relationship to the basic coordinate system and the basic coordinate system to aero-coordinate system are to be specified in the coordinate input card immediately following the namelist input. The grid card and the element card are to be separated and placed after the coordinate system specification, with a card specifying their numbers placed behind the coordinate card.

The input for the wing-only case requires the specification of both the wing planform and its surface contour. The input for the description of the wing planform requires the coordinates of corner points and break points. For each individual wing, inputs for those of quadrilateral shape are their four corner coordinates. The codes have allocated the first four values of the coordinates XWI, YWI and ZWI for each wing or wing region, arranged in a counterclockwise order starting from the leading-edge corner of break point.

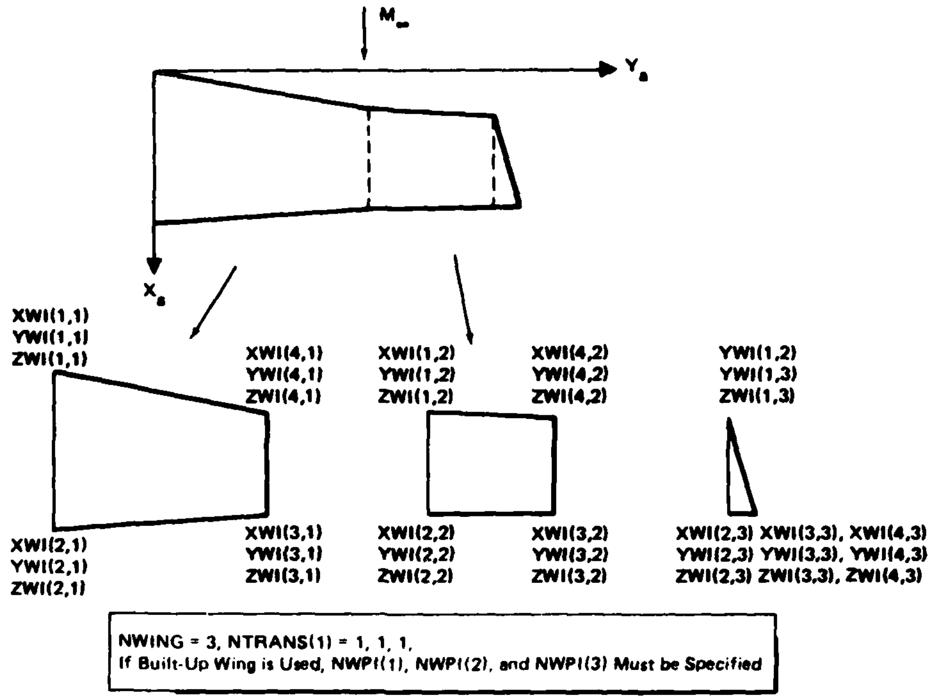


Figure 4-2. Subdivision of Complex Wing

In the case of triangular wings, there are only three corner points. To satisfy the same requirement, the apex or wing tip is to be considered as two coincident points of the same coordinate. The inputs are to be arranged like those of the quadrilateral shape, with leading-edge body-corner point as the starting point. Wings with complex shapes (see Figure 4-2) must be subdivided into appropriate quadrilateral or triangular regions and the inputs prepared accordingly. The only requirement is that the control chords, apart from either the leading edge or the trailing edge, must be in the streamwise direction.

All inputs for the wing surface are to be given in the form of the equation of surface Z = f(x, y) in terms of XWI, YWI and ZWI. Starting with the fifth value, XWI (5,I), YWI (5,I), ZWI (5,I), their total number may not exceed 26 points. For wings with flat surfaces, only the first four points are necessary.

Inputs defining wing thickness, camber and twist have been eliminated to reduce the input preparation effort. The code generates the required values of camber, thickness slope, and twist angle for the wing using the existing surface-fit scheme from the input.

Similar to the body-only case, the finite-element and grid-point coordinate-system cards are placed immediately behind the namelist input. They are followed by a card specifying the number of grid cards and element cards. The grid-point and element card as generated by PING occupies the last position in the input.

The coordinate system used for the wing can be any one of three systems, i.e., rectilinear (x,y,z), cylindrical (r,θ,z) and spherical (r,θ,φ). In terms of the input parameters, they are represented by XWI, YWI and ZWI, respectively, for all three systems.

For the complete-missile case, the input can be considered as a combination of these two cases, i.e., the body-only and the wing-only cases. Only the parameters ICASE and NTRANS need be corrected to reflect the changes.

Both coordinate-system cards and finite-element cards are to be grouped together in the order of body, wings, and nacelles.

As a result of the approach used for the analysis, the computations for the high-supersonic-flow case are considerably simpler. Accordingly, the code treats the complete missile as a rule.

As previously noted, for aerodynamic heating analysis, inputs for missile dimensions such as XB, RB, ZD, XWI, YWI, ZWI, XLG, XTG and the finite element grid inputs must be given in inches. The free stream pressure PINF should be in psi.

The additional inputs, required for either the heating transfer analysis or the blunted nose case are described below.

4.2.1 Aerodynamic Heating Analysis

IHTRANF	= 0	No heat transfer analysis, default value
	= 1	Heat transfer analysis requested
TI	= 518.0°R	Free stream temperature, default value
TEMPI	= 540.0°R	Initial temperature of missile, default value
BMATL		Body skin material flag
	= 1.0	Aluminum ($A\ell$), default value
	= 2.0	Titanium
	= 3.0	Input, as desired, the specific heat (Btu/lb-°F), Density (lb/ft^3) and emittance
BSPHT	= 0.2	Specific heat of body skin material (Btu/lb-°F), default value ($A\ell$)
BDENS	= 173.0	Density of body skin material (lb/ft^3), default value ($A\ell$)
BEPS	= 0.2	Infrared emittance of body skin material, default value ($A\ell$)
BTHICK	= 0.1	Thickness of body skin (inch), default value
WMATL		Wing skin material flag
	= 1.0	Aluminum, default value

	= 2.0	Titanium
	= 3.0	Input, as desired, the specific heat (Btu/lb-°F), density (lb/ft^3) and emittance
WSPHT	= 0.2	Specific heat of wing skin material (Btu/lb-°f), default value (Aℓ)
WDENS	= 173.0	Density of wing skin material (lb/ft^3), default value (Aℓ)
WEPS	= 0.2	Infrared emittance of wing skin material, default value (Aℓ)
WTHICK	= 0.1	Thickness of wing skin (inch), default value

4.2.2 Blunted Nose

INOSE	= 0	Sharp nose case
	= 1	Slightly blunted nose
RNOSE		Nose radius

Section 5

TEST CASES

Test cases were selected for aerodynamic heating analysis and nose pressure modification using the present code for the purpose of verifying the theoretical approach and the code operation.

5.1 SHARP CONE AT $M_\infty = 4.98$

Results of computations for heat transfer to a sharp, five degree semi-apex angle cone at $M_\infty = 4.98$ are shown in Figure 5-1 compared with experimental data from Reference 14. The calculated results demonstrate a transition criterion of a local Reynolds number between 4×10^6 and 6×10^6 to correspond with transition observed in the test data. Comparison of calculated results with experimental data for both laminar and turbulent boundary layer heat transfer is seen to be very good.

5.2 PRESSURE DISTRIBUTION OF A SLIGHTLY BLUNTED NOSE MISSILE

For analyzing a missile with a slightly blunted nose, the test results of a circular cone with a 15° half-cone angle at $M_\infty = 1.9$ as reported in Reference 15 was available. In Reference 16, a test for an ogive with a blunted nose was conducted at $M_\infty = 2.17$ and 4.84. In Figures 5-2, 5-3 and 5-4 their measured pressure data were compared with the calculated results generated by the code. It can be seen that the correlation is good.

For subsonic speeds, test results for a hemisphere-cylinder at $M_\infty = 0.8$ were reported in Reference 18. In Figure 5-5, it can be seen that calculated results compare favorably with these data.

The input requirement for the blunted nose code is relatively simple. Only two additional inputs are needed, i.e., INOSE and RNOSE.

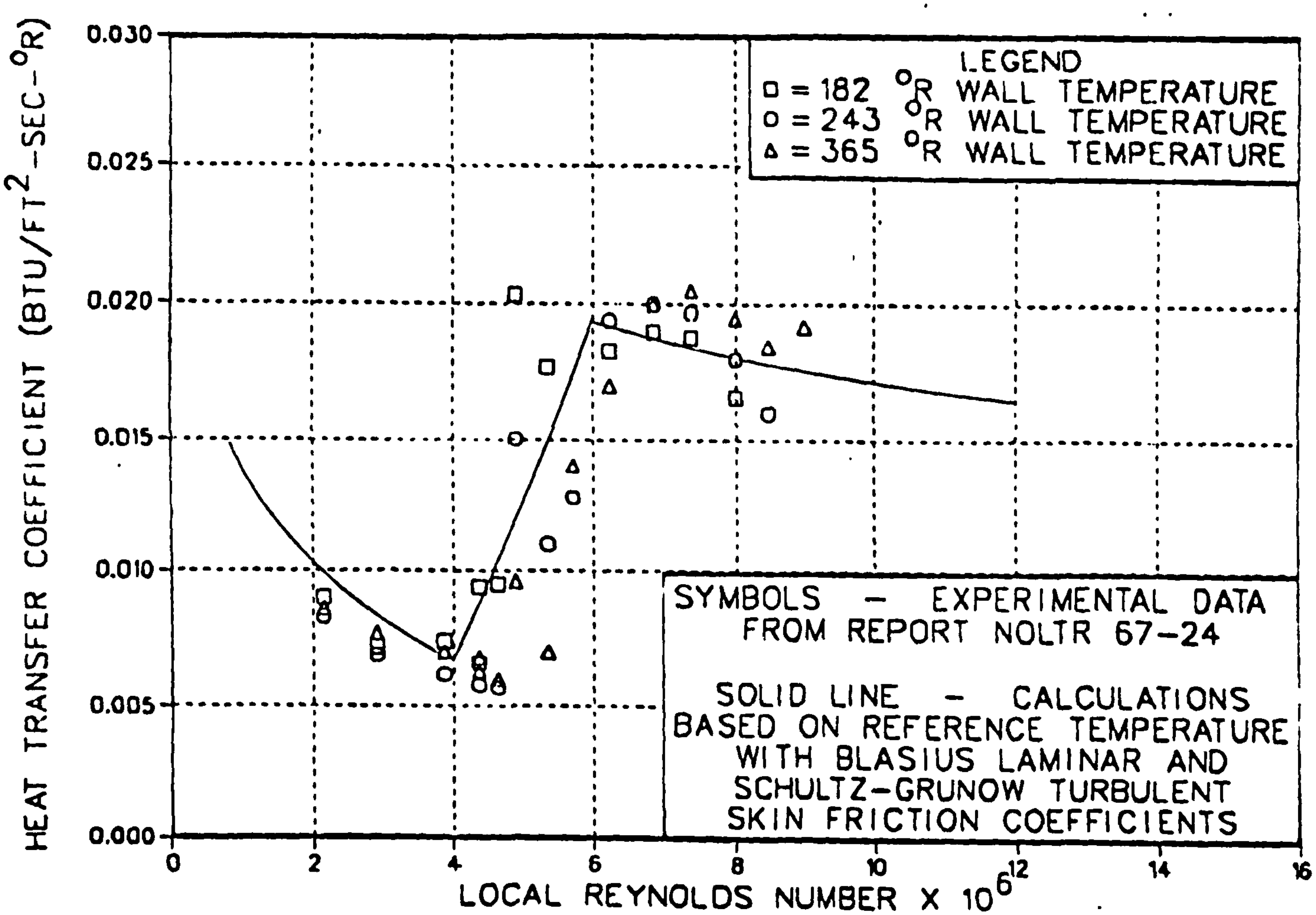


Figure 5-1. EXPERIMENTAL DATA COMPARISON

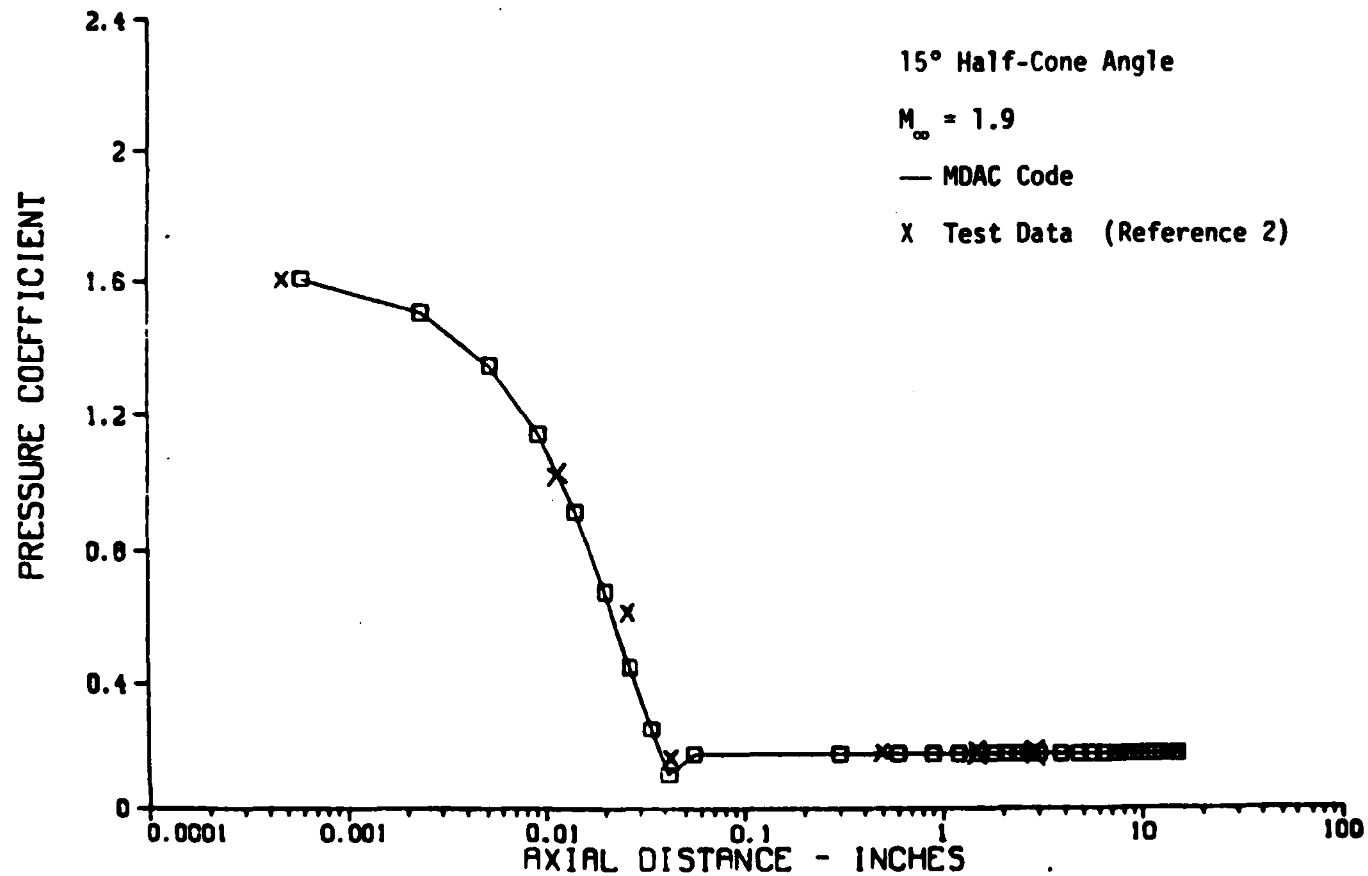


Figure 5-2. Pressure Coefficient of a Slightly Blunted Cone.

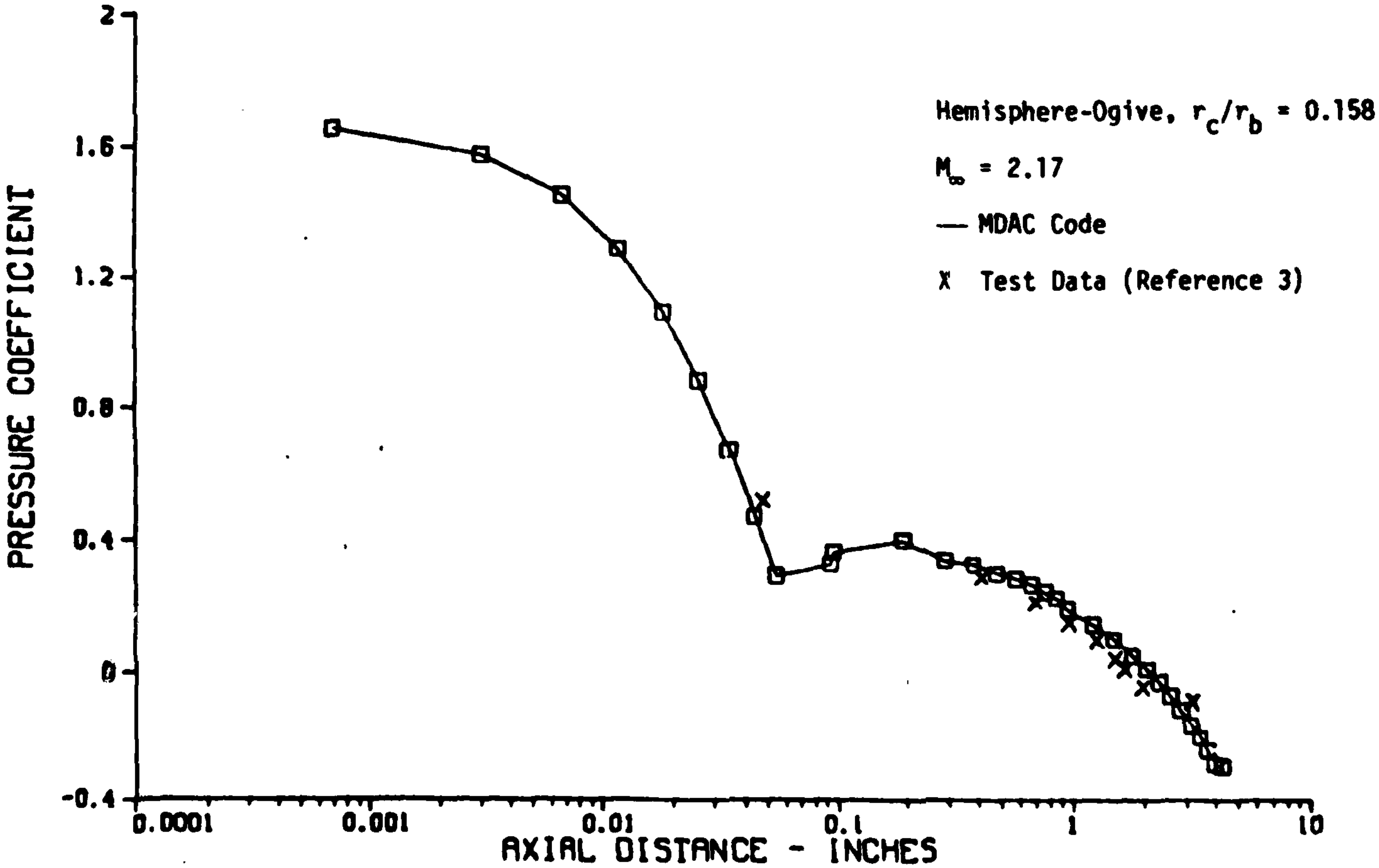


Figure 5-3. Pressure Coefficient of a Slightly Blunted Ogive.

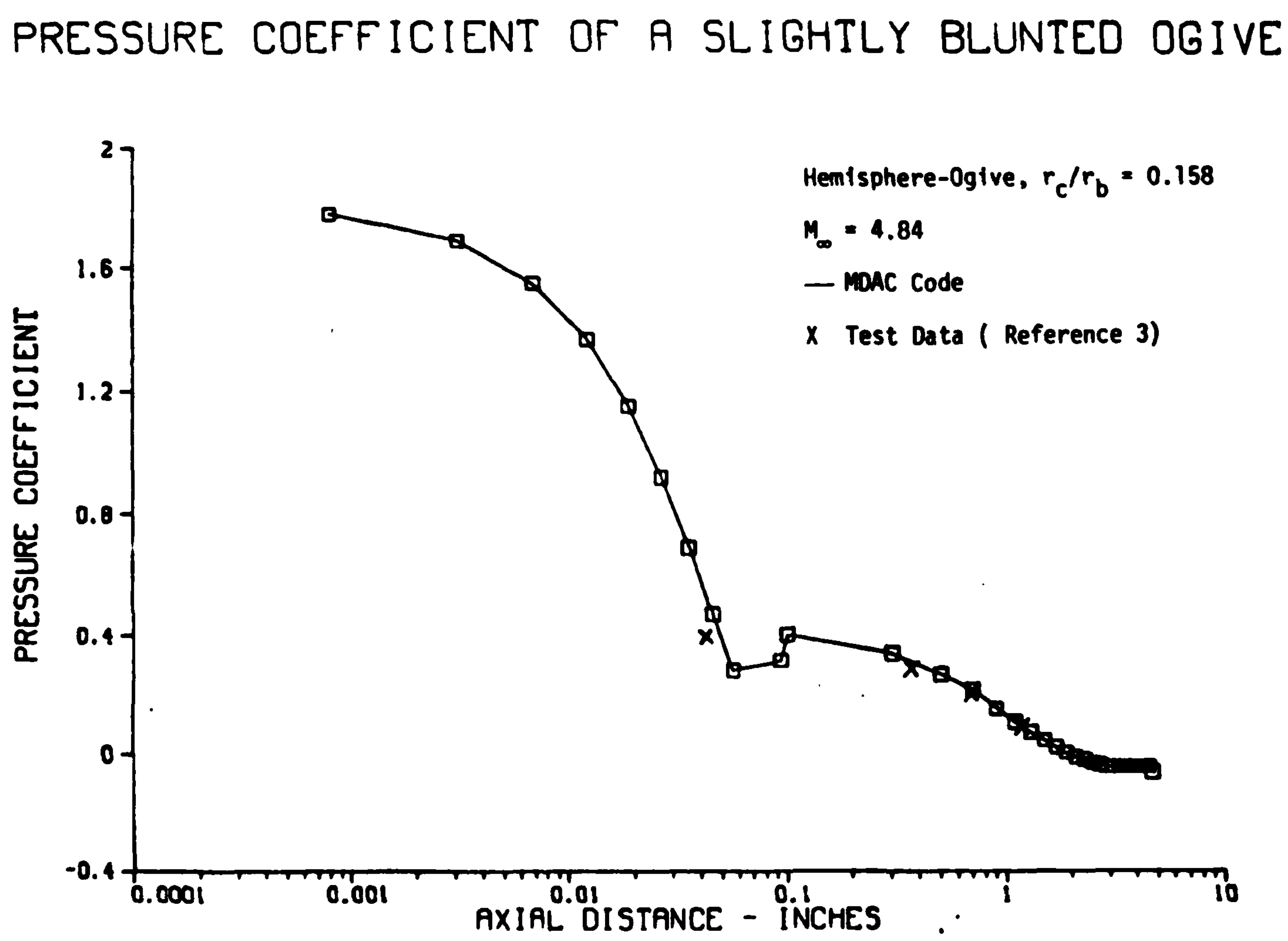


Figure 5-4. Pressure Coefficient of a Slightly Blunted Ogive

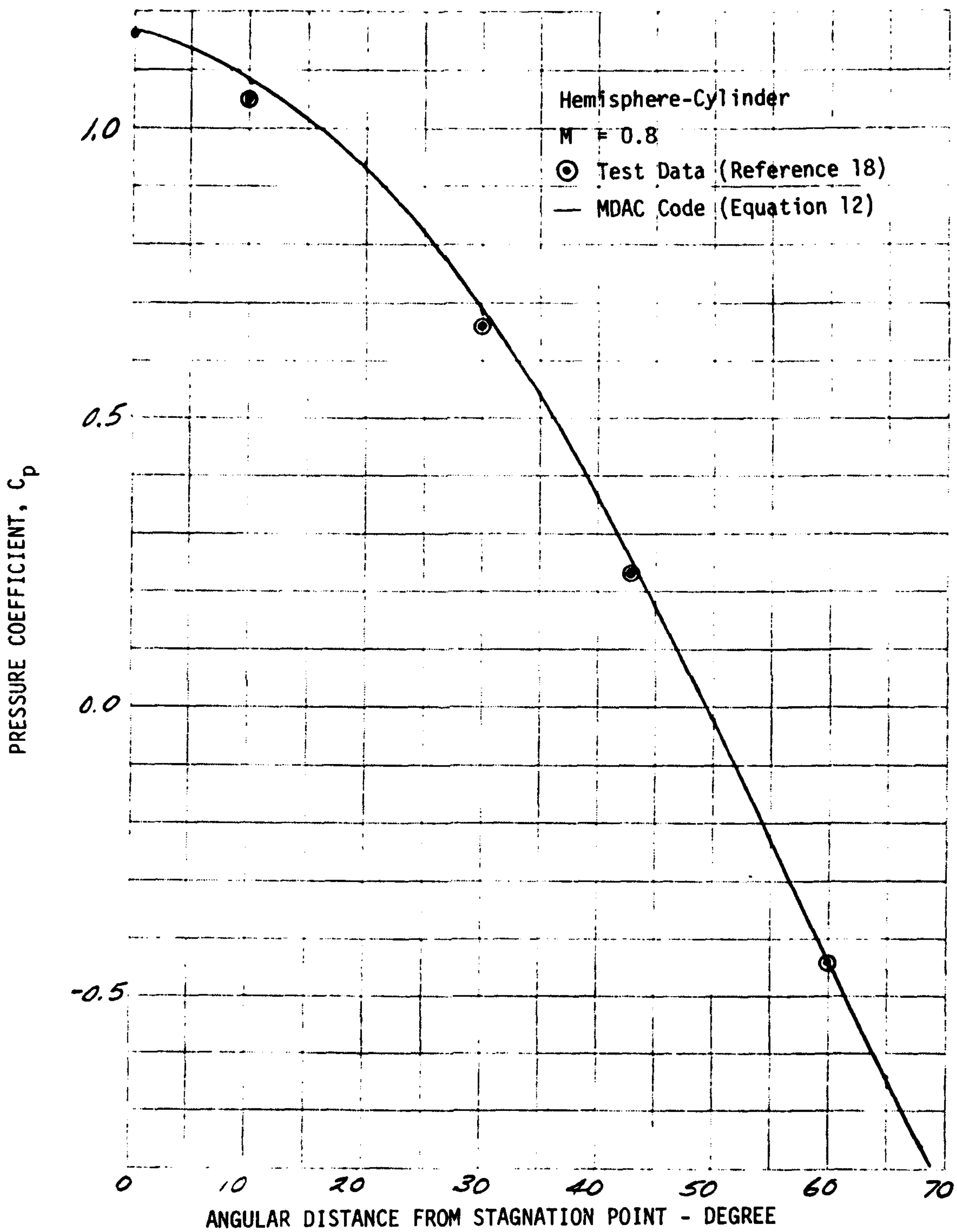


Figure 5-5. Pressure Coefficient of Hemisphere-Cylinder

Section 6

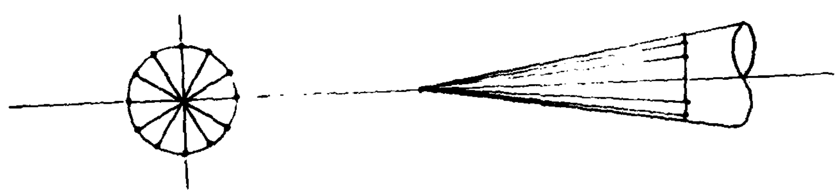
SAMPLE INPUTS AND OUTPUTS

For the convenience of the user, sample inputs and outputs from calculations are presented.

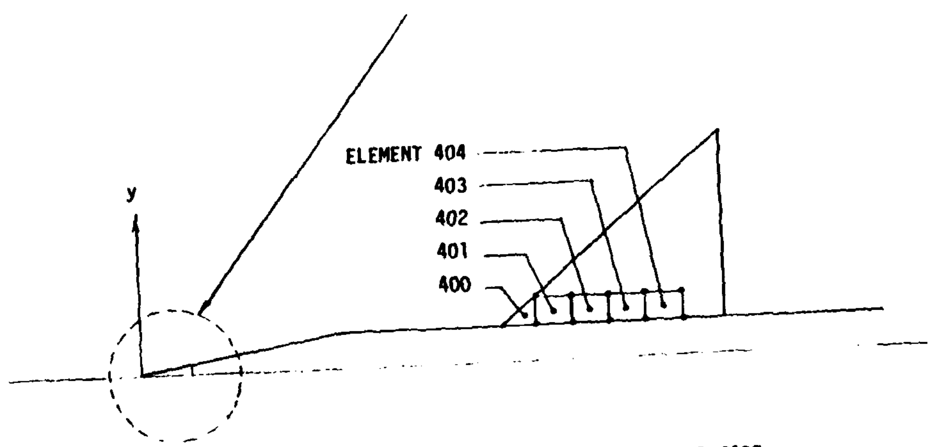
6.1 SAMPLE INPUTS

6.1.1 Aerodynamic Heating Case

For clarity, grid points and elements selected for the sample test case are shown in the sketch (only a few are shown for demonstration purposes).



EXPANDED VIEW OF NOSE ELEMENTS



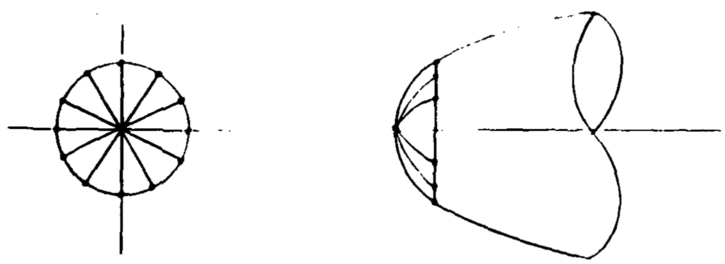
• GRID POINT OF ELEMENT USED IN THE TEST CASE

ELEMENTS AND GRID POINTS OF SAMPLE TEST CASE

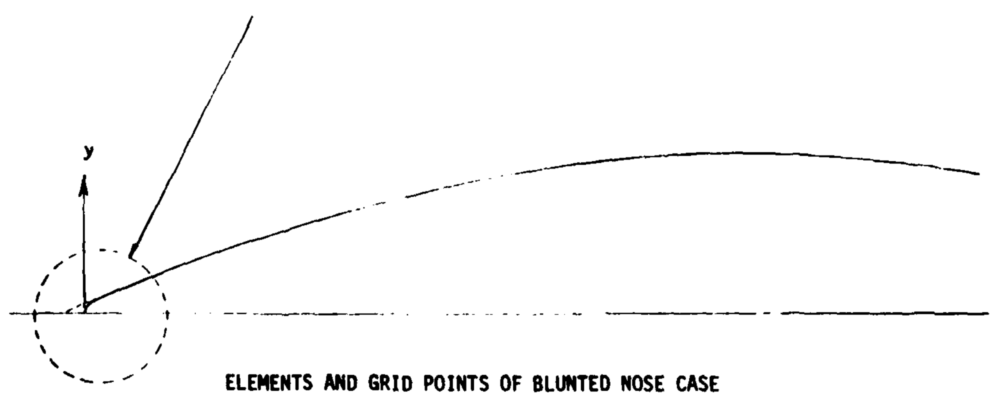
```
A01                                                                                              A01
  SAMPLE CASE FOR HEAT TRANSFER ANALSIS OF A COMPLETE MISSILE
$UNIFID
  ICASE=3, NTRANS(1)= 1, 1, NBPFL= 15, NWPI(1) =  4, NWING = 1,
   ARB= 0.000, XMACH = 5.00, YAW= 0.00,  BROLL =  0.0, IFORM(1) =2,
   THICK = 1.0, NWPANL = 1, PINF = 14.7, XLG(1) = 6.503, XTG(1) =10.718,
   ISOLID = 0, IHTRANF = 1, TI = 230.0, IPUNCH = 1,
   BMATL = 3.0, BSPHT = 0.2, BDENS = 173.0, BEPS =0.2, BTHICK = 0.12,
   WMATL = 3.0, WSPHT = 0.2, WDENS = 173.0, WEPS =0.4, WTHICK = 0.08,
   TEMPI = 520.0,
   XB(1) = 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.3, 3.403, 3.5, 5.5,
     7.5, 9.5, 12.0, 15.0,
   RB(1) = 0.0, 0.0881, 0.1763, 0.2664, 0.3526, 0.4408, 0.5289, 0.5818,
     7*0.6,
   XWI(1,1) = 6.503, 3*10.718,
   YWI(1,1) = 2*0.6, 2*4.137,
   ZWI(1,1) = 0.0, 0.184, 0.0, 0.184,
$END
CORD2C         1       0     0.0     0.0     0.0     1.0     0.0     0.0
             1.0     0.0     1.0
CORD2R         3       0     0.0     0.0     0.0     0.0     0.0     1.0
             1.0     0.0     1.0
        13          11
GRID           1       0   0.000   0.000   0.000       0       4
GRID           2       1    .071   0.000    .403       1       4
GRID           3       1    .071  30.000    .403       1       4
GRID           4       1    .071  60.000    .403       1       4
GRID           5       1    .071  90.000    .403       1       4
GRID           6       1    .071 120.000    .403       1       4
GRID           7       1    .071 150.000    .403       1       4
GRID           8       1    .071 180.000    .403       1       4
GRID           9       1    .071 210.000    .403       1       4
GRID          10       1    .071 240.000    .403       1       4
GRID          11       1    .071 270.000    .403       1       4
GRID          12       1    .071 300.000    .403       1       4
GRID          13       1    .071 330.000    .403       1       4
CTRIA2         1       1       3       2       1   0.000
CTRIA2         2       2       4       3       1   0.000
CTRIA2         3       3       5       4       1   0.000
CTRIA2         4       4       6       5       1   0.000
CTRIA2         5       5       7       6       1   0.000
CTRIA2         6       6       8       7       1   0.000
CTRIA2         7       7       9       8       1   0.000
CTRIA2         8       8      10       9       1   0.000
CTRIA2         9       9      11      10       1   0.000
CTRIA2        10      10      12      11       1   0.000
CTRIA2        11      11      13      12       1   0.000
        11           5
GRID          83       3  6.5030     0.6     0.0       3
GRID          95       3  7.2055     0.6     0.0       3
GRID         107       3  7.9080     0.6     0.0       3
GRID         119       3  8.6110     0.6     0.0       3
GRID         131       3  9.3130     0.6     0.0       3
GRID         143       3  10.016     0.6     0.0       3
GRID         211       3  7.2055  1.1895  0.0000       3
GRID         221       3  7.9079  1.1895  0.0000       3
GRID         231       3  8.6105  1.1895  0.0000       3
GRID         241       3  9.3130  1.1895  0.0000       3
GRID         251       3  10.015  1.1895  0.0000       3
CTRIA2       400     400      83      95     211  0.0000
CQUAD2       401     401      95     107     221     211  0.0000
CQUAD2       402     402     107     119     231     221  0.0000
CQUAD2       403     403     119     131     241     231  0.0000
CQUAD2       404     404     131     143     251     241  0.0000
```

6.1.2 Blunted Nose Case

In the sketch shown, the blunted nose ogive has its elements and grid points as given by the input. With the method of analysis for the blunted nose restricted to a slightly blunted body, the number of elements can be small as used for the test case.



EXPANDED VIEW OF NOSE ELEMENTS



ELEMENTS AND GRID POINTS OF BLUNTED NOSE CASE

```
A01
   SAMPLE CASE FOR ANALYZE MISSILE WITH A SLIGHTLY BLUNTED NOSE
 $UNIFID
   ICASE=2, NTRANS(1)= 1, 1, NBPFL= 20, ARB = 0.0, XMACH = 2.0,
    PINF = 14.7, INOSE = 1, RNOSE = 0.0935,
    XB(1) = 0.0, 0.2, .261, .35, .439, .529, .619, .711, 1.08, 1.551,
     2.03, 2.415, 2.512, 2.647, 2.936, 3.423, 3.613, 3.898, 4.366, 4.826,
    RB(1) = 0.0, .0928, .1247, .1632, .2002, .2356, .269, .302, .415,
     .519, .582, .602, .603, .6015, .587, .527, .492, .427, .283, .0962,
 $END
CORD2C         1       0     0.0     0.0     0.0     1.0     0.0     0.0
             1.0     0.0     1.0
      26          17
GRID           1       0   0.000   0.000   0.000       0       4
GRID           2       1    .187   0.000    .403       1       4
GRID           3       1    .187  30.000    .403       1       4
GRID           4       1    .187  60.000    .403       1       4
GRID           5       1    .187  90.000    .403       1       4
GRID           6       1    .187 120.000    .403       1       4
GRID           7       1    .187 150.000    .403       1       4
GRID           8       1    .187 180.000    .403       1       4
GRID           9       1    .187 210.000    .403       1       4
GRID          10       1    .187 240.000    .403       1       4
GRID          11       1    .187 270.000    .403       1       4
GRID          12       1    .187 300.000    .403       1       4
GRID          13       1    .187 330.000    .403       1       4
GRID          21       0   0.000   0.000   0.000       0       4
GRID          22       1    .066   0.000   .0274       1       4
GRID          23       1    .066  30.000   .0274       1       4
GRID          24       1    .066  60.000   .0274       1       4
GRID          25       1    .066  90.000   .0274       1       4
GRID          26       1    .066 120.000   .0274       1       4
GRID          27       1    .066 150.000   .0274       1       4
GRID          28       1    .066 180.000   .0274       1       4
GRID          29       1    .066 210.000   .0274       1       4
GRID          30       1    .066 240.000   .0274       1       4
GRID          31       1    .066 270.000   .0274       1       4
GRID          32       1    .066 300.000   .0274       1       4
GRID          33       1    .066 330.000   .0274       1       4
CTRIA2         1       1       3       2       1   0.000
CTRIA2         2       2       4       3       1   0.000
CTRIA2         3       3       5       4       1   0.000
CTRIA2         4       4       6       5       1   0.000
CTRIA2         5       5       7       6       1   0.000
CTRIA2         6       6       8       7       1   0.000
CTRIA2         7       7       9       8       1   0.000
CTRIA2         8       8      10       9       1   0.000
CTRIA2         9       9      11      10       1   0.000
CTRIA2        10      10      12      11       1   0.000
CTRIA2        11      11      13      12       1   0.000
CTRIA2        12      12       2      13       1   0.000
CTRIA2        21      21      23      22      21   0.000
CTRIA2        22      22      24      23      21   0.000
CTRIA2        23      23      25      24      21   0.000
CTRIA2        24      24      26      25      21   0.000
CTRIA2        25      25      27      26      21   0.000
```

6.2 OUTPUT OF CALCULATIONS

Printouts of the results as calculated using the code are reproduced in the following pages. For the heating analysis case only a few selected elements were used for demonstration purposes. In application when a large number of elements is involved, the temperature history will be written on tape 12 to reduce the punched output and facilitate the handling of output.

6.2.1 Aerodynamic Heating Analysis

```
A01
   SAMPLE CASE FOR HEAT TRANSFER ANALSIS OF A COMPLETE MISSILE                                                    A01

 E01                                                                                                              E01
SUNIFID
ICASE   = 3,
NTRANS  = 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
IPUNCH  = 1,
IRW     = 0,
POLAR   = 0.0,
ISOLID  = 0,
SID     = .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,     .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,
          .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,
NBPFL   = 15,
XB      = 0.0, .5E+00, .1E+01, .15E+01, .2E+01, .25E+01, .3E+01, .33E+01,      .3403E+01, .35E+01, .55E+01, .75E+01,
          .95E+01, .12E+02, .15E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,    0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
RB      = 0.0, .881E-01, .1763E+00, .2664E+00, .3526E+00, .4408E+00, .5289E+00, .5818E+00, .6E+00, .6E+00, .6E+00,
          .6E+00, .6E+00, .6E+00, .6E+00, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,   0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0,
ZD      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
RP      = 0.0,
NWPI    = 4, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
YAW     = 0.0,
BROLL   = 0.0,
NWING   = 1,
IFORM   = 2, 0, 0, 0, 0, 0, 0, 0, 0, 0,
PIVOT   = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
THICK   = .1E+01,
DIHED   = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.C, 0.0, 0.0, 0.0,
XWI     = .6503E+01, .10718E+02, .10718E+02, .10718E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
```

```
C01                                                                                              C01
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
YWI   = .6E+00, .6E-00, .4137E+01, .4137E+01, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
ZWI   = 0.0, .184E+00, 0.0, .184E+00, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
```

```
D01                                                                                                   D01
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
XNACEL  = 0.0,
NACELP  = 0,
XN      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
RN      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
ZN      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
NWPANL  = 1,
XLG     = .6503E+01, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
XTG     = .10718E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
XMACH   = .5E+01,
PINF    = .147E+02,
DADEG   = 0.0,
ARB     = 0.0,
ARW     = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
IHTRANF = 1,
INOSE   = 0,
RNOSE   = 0.0,
TI      = .23E+03,
BMATL   = .3E+01,
BSPHT   = .2E+00,
BDENS   = .173E+03,
BTHICK  = .12E+00,
BEPS    = .2E+00,
```

```
 E01                                                        E01
WMATL   = .3E+01,
WSPHT   = .2E+00,
WDENS   = .173E+03,
WTHICK  = .8E-01,
WEPS    = .4E+00,
TEMPI   = .52E+03,
$END
```

F01 F01

PRESSURES, FORCES AND MOMENTS ON ISOLATED BODY

CD = .0121 CL = .0000 CB = 0.0000 CPM = .0000 CRM = 0.0000 CYM = 0.0000

BODY PRESSURE COEFFICIENTS (CP)

THETA (DEG) / X	0.0000	30.0000	60.0000	90.0000	120.0000	150.0000	180.0000
0.0000	.0758	.0758	.0758	.0758	.0758	.0758	.0758
.3125	.0750	.0750	.0750	.0750	.0750	.0750	.0750
.9375	.0766	.0766	.0766	.0766	.0766	.0766	.0766
1.5625	.0751	.0751	.0751	.0751	.0751	.0751	.0751
2.1875	.0697	.0697	.0697	.0697	.0697	.0697	.0697
2.8125	.0668	.0668	.0668	.0668	.0668	.0668	.0668
3.4375	-.0180	-.0180	-.0180	-.0180	-.0180	-.0180	-.0180
4.0625	-.0162	-.0162	-.0162	-.0162	-.0162	-.0162	-.0162
4.6875	-.0136	-.0136	-.0136	-.0136	-.0136	-.0136	-.0136
5.3125	-.0115	-.0115	-.0115	-.0115	-.0115	-.0115	-.0115
5.9375	-.0098	-.0098	-.0098	-.0098	-.0098	-.0098	-.0098
6.5625	-.0080	-.0080	-.0080	-.0080	-.0080	-.0080	-.0080
7.1875	-.0062	-.0062	-.0062	-.0062	-.0062	-.0062	-.0062
7.8125	-.0043	-.0043	-.0043	-.0043	-.0043	-.0043	-.0043
8.4375	-.0024	-.0024	-.0024	-.0024	-.0024	-.0024	-.0024
9.0625	-.0006	-.0006	-.0006	-.0006	-.0006	-.0006	-.0006
9.6875	.0011	.0011	.0011	.0011	.0011	.0011	.0011
10.3125	.0027	.0027	.0027	.0027	.0027	.0027	.0027
10.9375	.0043	.0043	.0043	.0043	.0043	.0043	.0043
11.5625	.0059	.0059	.0059	.0059	.0059	.0059	.0059
12.1875	.0074	.0074	.0074	.0074	.0074	.0074	.0074
12.8125	.0090	.0090	.0090	.0090	.0090	.0090	.0090
13.4375	.0104	.0104	.0104	.0104	.0104	.0104	.0104
14.0625	.0119	.0119	.0119	.0119	.0119	.0119	.0119
14.6875	-.0571	-.0571	-.0571	-.0571	-.0571	-.0571	-.0571

G01 MACH NO. ON THE CONTROL PANEL

G01

0.0000	4.5103	4.5103	4.5103	4.5103	4.5103	4.5103	4.5103
.3125	4.5151	4.5151	4.5151	4.5151	4.5151	4.5151	4.5151
.9375	4.4957	4.4957	4.4957	4.4957	4.4957	4.4957	4.4957
1.5625	4.5223	4.5223	4.5223	4.5223	4.5223	4.5223	4.5223
2.1875	4.5748	4.5748	4.5748	4.5748	4.5748	4.5748	4.5748
2.8125	4.5750	4.5750	4.5750	4.5750	4.5750	4.5750	4.5750
3.4375	5.5719	5.5719	5.5719	5.5719	5.5719	5.5719	5.5719
4.0625	5.5313	5.5313	5.5313	5.5313	5.5313	5.5313	5.5313
4.6875	5.4738	5.4738	5.4738	5.4738	5.4738	5.4738	5.4738
5.3125	5.4307	5.4307	5.4307	5.4307	5.4307	5.4307	5.4307
5.9375	5.3980	5.3980	5.3980	5.3980	5.3980	5.3980	5.3980
6.5625	5.3653	5.3653	5.3653	5.3653	5.3653	5.3653	5.3653
7.1875	5.3321	5.3321	5.3321	5.3321	5.3321	5.3321	5.3321
7.8125	5.2989	5.2989	5.2989	5.2989	5.2989	5.2989	5.2989
8.4375	5.2681	5.2681	5.2681	5.2681	5.2681	5.2681	5.2681
9.0625	5.2397	5.2397	5.2397	5.2397	5.2397	5.2397	5.2397
9.6875	5.2137	5.2137	5.2137	5.2137	5.2137	5.2137	5.2137
10.3125	5.1891	5.1891	5.1891	5.1891	5.1891	5.1891	5.1891
10.9375	5.1658	5.1658	5.1658	5.1658	5.1658	5.1658	5.1658
11.5625	5.1436	5.1436	5.1436	5.1436	5.1436	5.1436	5.1436
12.1875	5.1224	5.1224	5.1224	5.1224	5.1224	5.1224	5.1224
12.8125	5.1023	5.1023	5.1023	5.1023	5.1023	5.1023	5.1023
13.4375	5.0831	5.0831	5.0831	5.0831	5.0831	5.0831	5.0831
14.0625	5.0649	5.0649	5.0649	5.0649	5.0649	5.0649	5.0649
14.6875	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

A02

TEMPERATURE (R) ON THE CONTROL PANEL

0.0000	292.7421	292.7421	292.7421	292.7421	292.7421	292.7421	292.7421
.3125	292.2401	292.2401	292.2401	292.2401	292.2401	292.2401	292.2401
.9375	293.2854	293.2854	293.2854	293.2854	293.2854	293.2854	293.2854
1.5625	292.3207	292.3207	292.3207	292.3207	292.3207	292.3207	292.3207
2.1875	288.8225	288.8225	288.8225	288.8225	288.8225	288.8225	288.8225
2.8125	286.9515	286.9515	286.9515	286.9515	286.9515	286.9515	286.9515
3.4375	206.4310	206.4310	206.4310	206.4310	206.4310	206.4310	206.4310
4.0625	209.0466	209.0466	209.0466	209.0466	209.0466	209.0466	209.0466
4.6875	212.8288	212.8288	212.8288	212.8288	212.8288	212.8288	212.8288
5.3125	215.7240	215.7240	215.7240	215.7240	215.7240	215.7240	215.7240
5.9375	217.9612	217.9612	217.9612	217.9612	217.9612	217.9612	217.9612
6.5625	220.2364	220.2364	220.2364	220.2364	220.2364	220.2364	220.2364
7.1875	222.5762	222.5762	222.5762	222.5762	222.5762	222.5762	222.5762
7.8125	224.9486	224.9486	224.9486	224.9486	224.9486	224.9486	224.9486
8.4375	227.1866	227.1866	227.1866	227.1866	227.1866	227.1866	227.1866
9.0625	229.2704	229.2704	229.2704	229.2704	229.2704	229.2704	229.2704
9.6875	231.2122	231.2122	231.2122	231.2122	231.2122	231.2122	231.2122
10.3125	233.0618	233.0618	233.0618	233.0618	233.0618	233.0618	233.0618
10.9375	234.8391	234.8391	234.8391	234.8391	234.8391	234.8391	234.8391
11.5625	236.5488	236.5488	236.5488	236.5488	236.5488	236.5488	236.5488
12.1875	238.1947	238.1947	238.1947	238.1947	238.1947	238.1947	238.1947
12.8125	239.7745	239.7745	239.7745	239.7745	239.7745	239.7745	239.7745
13.4375	241.2900	241.2900	241.2900	241.2900	241.2900	241.2900	241.2900
14.0625	242.7448	242.7448	242.7448	242.7448	242.7448	242.7448	242.7448
14.6875	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

FORCES AND MOMENTS ON WING

CD = .0018 CL = 0.0000 CB = 0.0000 CPM = 0.0000 CRM = 0.0000 CYM = -.0031

UPPER SURFACE WING PANEL PRESSURE COEFF. (CP)

SPANWISE STATION / CHORDWISE STATION	1	2	3	4	5
1	.02026	.02026	.02026	.02026	.02026
2	.02026	.02026	.02026	.02026	.02026
3	.02026	.02026	.02026	.02026	.02026
4	.02026	.02026	.02026	.02026	.02026
5	.02026	.02026	.02026	.02026	.02026
6	.02026	.02026	.02026	.02026	.02026
7	.02026	.02026	.02026	.02026	.02026
8	.02026	.02026	.02026	.02026	.02026

LOWER SURFACE WING PANEL PRESSURE COEFF. (CP)

SPANWISE STATION / CHORDWISE STATION	1	2	3	4	5
1	.02026	.02026	.02026	.02026	.02026
2	.02026	.02026	.02026	.02026	.02026
3	.02026	.02026	.02026	.02026	.02026
4	.02026	.02026	.02026	.02026	.02026
5	.02026	.02026	.02026	.02026	.02026
6	.02026	.02026	.02026	.02026	.02026
7	.02026	.02026	.02026	.02026	.02026
8	.02026	.02026	.02026	.02026	.02026

C02 C02

AERODYNAMIC PRESSURE ON THE BODY - - CENTROID OF FINITE ELEMENT AS GENERATED BY NSWC CODE IN THE SAME LOCAL COORDINATE SYSTEM

ELEMENT	X	THETA	PRESSURE	TEMP R	MACH NO.
1	.269E+00	.345E+03	.193E+02	292.173	4.514
2	.269E+00	.315E+03	.193E+02	292.264	4.515
3	.269E+00	.285E+03	.193E+02	292.173	4.514
4	.269E+00	.255E+03	.193E+02	292.173	4.514
5	.269E+00	.225E+03	.193E+02	292.264	4.515
6	.269E+00	.195E+03	.193E+02	292.173	4.514
7	.269E+00	.165E+03	.193E+02	292.173	4.514
8	.269E+00	.135E+03	.193E+02	292.264	4.515
9	.269E+00	.105E+03	.193E+02	292.173	4.514
10	.269E+00	.750E+02	.193E+02	292.173	4.514
11	.269E+00	.450E+02	.193E+02	292.264	4.515

NUMBER OF CARD PUNCHED FOR THIS RUN 11

FLOW FIELD ON THE WING --- CONTROL POINT OF THE WING PANELS

PRESSURE AT CONTROL POINT - UPPER SURFACE

X	Y	PRESSURE	MACH NO	TEMP R
7.2708	.9406	.5212E+01	4.7419	251.04
7.7551	.9406	.5212E+01	4.7419	251.04
8.[illegible]448	.9406	.5212E+01	4.7419	251.04
8.7345	.9406	.5212E+01	4.7419	251.04
9.2243	.9406	.5212E+01	4.7419	251.04
9.7140	.9406	.5212E+01	4.7419	251.04
10.2038	.9406	.5212E+01	4.7419	251.04
10.6935	.9406	.5212E+01	4.7419	251.04
8.0296	1.6443	.5212E+01	4.7419	251.04
8.4073	1.6443	.5212E+01	4.7419	251.04
8.7893	1.6443	.5212E+01	4.7419	251.04
9.1712	1.6443	.5212E+01	4.7419	251.04
9.5531	1.6443	.5212E+01	4.7419	251.04
9.9350	1.6443	.5212E+01	4.7419	251.04
10.3170	1.6443	.5212E+01	4.7419	251.04
10.6989	1.6443	.5212E+01	4.7419	251.04
8.7853	2.3449	.5212E+01	4.7419	251.04
9.0568	2.3449	.5212E+01	4.7419	251.04
9.3314	2.3449	.5212E+01	4.7419	251.04
9.6060	2.3449	.5212E+01	4.7419	251.04
9.8805	2.3449	.5212E+01	4.7419	251.04
10.1551	2.3449	.5212E+01	4.7419	251.04
10.4297	2.3449	.5212E+01	4.7419	251.04
10.7043	2.3449	.5212E+01	4.7419	251.04
9.5312	3.0366	.5212E+01	4.7419	251.04
9.6980	3.0366	.5212E+01	4.7419	251.04
9.8666	3.0366	.5212E+01	4.7419	251.04
10.0352	3.0366	.5212E+01	4.7419	251.04
10.2038	3.0366	.5212E+01	4.7419	251.04
10.3724	3.0366	.5212E+01	4.7419	251.04
10.5410	3.0366	.5212E+01	4.7419	251.04
10.7096	3.0366	.5212E+01	4.7419	251.04
10.2094	3.6654	.5212E+01	4.7419	251.04
10.2808	3.6654	.5212E+01	4.7419	251.04
10.3531	3.6654	.5212E+01	4.7419	251.04
10.4254	3.6654	.5212E+01	4.7419	251.04
10.4976	3.6654	.5212E+01	4.7419	251.04
10.5699	3.6654	.5212E+01	4.7419	251.04
10.6421	3.6654	.5212E+01	4.7419	251.04
10.7144	3.6654	.5212E+01	4.7419	251.04

PRESSURE AT CONTROL POINT - LOWER SURFACE

X	Y	PRESSURE	MACH NO	TEMP R
7.2708	.9406	.5212E+01	4.7419	251.04
7.7551	.9406	.5212E+01	4.7419	251.04
8.2448	.9406	.5212E-01	4.7419	251.04
8.7345	.9406	.5212E-01	4.7419	251.04
9.2243	.9406	.5212E-01	4.7419	251.04
9.7140	.9406	.5212E-01	4.7419	251.04
10.2[illegible]	.9406	.5212E+01	4.7419	251.04
10.[illegible]	.9406	.5212E-01	4.7419	251.04

 E02

8.0296	1.6443	.5212E+01	4.7419	251.04
8.4073	1.6443	.5212E+01	4.7419	251.04
8.7893	1.6443	.5212E+01	4.7419	251.04
9.1712	1.6443	.5212E+01	4.7419	251.04
9.5531	1.6443	.5212E+01	4.7419	251.04
9.9350	1.6443	.5212E+01	4.7419	251.04
10.3170	1.6443	.5212E+01	4.7419	251.04
10.6989	1.6443	.5212E+01	4.7419	251.04
8.7853	2.3449	.5212E+01	4.7419	251.04
9.0568	2.3449	.5212E+01	4.7419	251.04
9.3314	2.3449	.5212E+01	4.7419	251.04
9.6060	2.3449	.5212E+01	4.7419	251.04
9.8805	2.3449	.5212E+01	4.7419	251.04
10.1551	2.3449	.5212E+01	4.7419	251.04
10.4297	2.3449	.5212E+01	4.7419	251.04
10.7043	2.3449	.5212E+01	4.7419	251.04
9.5312	3.0366	.5212E+01	4.7419	251.04
9.6980	3.0366	.5212E+01	4.7419	251.04
9.8666	3.0366	.5212E+01	4.7419	251.04
10.0352	3.0366	.5212E+01	4.7419	251.04
10.2038	3.0366	.5212E+01	4.7419	251.04
10.3724	3.0366	.5212E+01	4.7419	251.04
10.5410	3.0366	.5212E+01	4.7419	251.04
10.7096	3.0366	.5212E+01	4.7419	251.04
10.2094	3.6654	.5212E+01	4.7419	251.04
10.2808	3.6654	.5212E+01	4.7419	251.04
10.3531	3.6654	.5212E+01	4.7419	251.04
10.4254	3.6654	.5212E+01	4.7419	251.04
10.4976	3.6654	.5212E+01	4.7419	251.04
10.5699	3.6654	.5212E+01	4.7419	251.04
10.6421	3.6654	.5212E+01	4.7419	251.04
10.7144	3.6654	.5212E+01	4.7419	251.04

AERODYNAMIC PRESSURE ON THE WING - - CENTROID OF FINITE ELEMENT AS GENERATED BY NSWC CODE IN THE SAME LOCAL COORDINATE SYSTEM

TOTAL NUMBER OF WINGS 1

WING NO. 1

FLOW FIELD ON THE UPPER SURFACE OF WING

ELEMENT	X	Y	PRESSURE	TEMP R	MACH NO.
400	.697E+01	.797E+00	.521E+01	251.037	4.742
401	.756E+01	.895E+00	.521E+01	251.037	4.742
402	.826E+01	.895E+00	.521E+01	251.037	4.742
403	.896E+01	.895E+00	.521E+01	251.037	4.742
404	.966E+01	.895E+00	.521E+01	251.037	4.742

FLOW FIELD ON THE LOWER SURFACE OF WING

ELEMENT	X	Y	PRESSURE	TEMP R	MACH NO.
400	.697E+01	.797E+00	.521E+01	251.037	4.742
401	.756E+01	.895E+00	.521E+01	251.037	4.742
402	.826E+01	.895E+00	.521E+01	251.037	4.742
403	.896E+01	.895E+00	.521E+01	251.037	4.742
404	.966E+01	.895E+00	.521E+01	251.037	4.742

NUMBER OF CARD PUNCHED FOR THIS RUN 10

TEMPERATURE HISTORIES FOR BODY ELEMENTS

TEMPERATURE HISTORY FOR BODY ELEMENT NUMBER 1

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.149051E+03
.50	251.93	.114195E+03
1.00	398.73	.874773E+02
1.50	511.18	.670002E+02
2.00	597.30	.513084E+02
3.00	710.39	.306885E+02
4.00	780.74	.178510E+02
5.00	821.65	.103806E+02
6.00	845.44	.603543E+01
8.00	867.02	.209387E+01
10.00	874.73	.685814E+00
15.00	878.27	.388483E-01
20.00	878.47	.181069E-02
25.00	878.48	.843950E-04
30.00	878.48	.393358E-05
35.00	878.48	.183344E-06
40.00	878.48	.854798E-08
45.00	878.48	.400856E-09
50.00	878.48	.206217E-10

TEMPERATURE HISTORY FOR BODY ELEMENT NUMBER 2

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.149250E+03
.50	252.18	.114336E+03
1.00	399.16	.875779E+02
1.50	511.73	.670711E+02
2.00	597.94	.513581E+02
3.00	711.12	.307127E+02
4.00	781.52	.178617E+02
5.00	822.46	.103849E+02
6.00	846.26	.603675E+01
8.00	867.84	.209353E+01
10.00	875.[illegible]	.685425E+00
15.00	879.08	.387819E-01
20.00	879.28	.180538E-02
25.00	879.29	.840443E-04
30.00	879.29	.391244E-05
35.00	879.29	.182135E-06
40.00	879.29	.848151E-08
45.00	879.29	.396771E-09
50.00	879.29	.203961E-10

TEMPERATURE HISTORY FOR BODY ELEMENT NUMBER 3

TIME	TEMPERATURE	HEAT FLUX

 A03

(SECONDS)	(DEG F)	(BTU/FT2-SEC)
0.00	60.31	.149051E+03
.50	251.93	.114195E+03
1.00	398.73	.874773E+02
1.50	511.18	.670002E+02
2.00	597.30	.513084E+02
3.00	710.39	.306885E+02
4.00	780.74	.178510E+02
5.00	821.65	.103806E+02
6.00	845.44	.603543E+01
8.00	867.02	.209387E+01
10.00	874.73	.685814E+00
15.00	878.27	.388483E-01
20.00	878.47	.181069E-02
25.00	878.48	.843950E-04
30.00	878.48	.393358E-05
35.00	878.48	.183344E-06
40.00	878.48	.854782E-08
45.00	878.48	.400593E-09
50.00	878.48	.204601E-10

TEMPERATURE HISTORY FOR BODY ELEMENT NUMBER 4

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.149051E+03
.50	251.93	.114195E+03
1.00	398.73	.874773E+02
1.50	511.18	.670002E+02
2.00	597.30	.513084E+02
3.00	710.39	.306885E+02
4.00	780.74	.178510E+02
5.00	821.65	.103806E+02
6.00	845.44	.603543E+01
8.00	867.02	.209387E+01
10.00	874.73	.685814E+00
15.00	878.27	.388483E-01
20.00	878.47	.181069E-02
25.00	878.48	.843950E-04
30.00	878.48	.393358E-05
35.00	878.48	.183344E-06
40.00	878.48	.854742E-08
45.00	878.48	.400297E-09
50.00	878.48	.213891E-10

TEMPERATURE HISTORY FOR BODY ELEMENT NUMBER 5

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.149250E+03
.50	252.19	.114336E+03
1.00	399.16	.875779E+02
1.50	511.73	.670711E+02
2.00	597.94	.513581E+02
3.00	711.12	.307127E+02

4.00	781.52	.178617E+02
5.00	822.46	.103849E+02
6.00	846.26	.603675E+01
8.00	867.84	.209353E+01
10.00	875.54	.685425E+00
15.00	879.08	.387819E-01
20.00	879.28	.180538E-02
25.00	879.29	.840443E-04
30.00	879.29	.391244E-05
35.00	879.29	.182135E-06
40.00	879.29	.848144E-08
45.00	879.29	.396703E-09
50.00	879.29	.203286E-10

TEMPERATURE HISTORY FOR BODY ELEMENT NUMBER 6

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.149051E+03
.50	251.93	.114195E+03
1.00	398.73	.874773E+02
1.50	511.18	.670002E+02
2.00	597.30	.513084E+02
3.00	710.39	.306885E+02
4.00	780.74	.178510E+02
5.00	821.65	.103806E+02
6.00	845.44	.603543E+01
8.00	867.02	.209387E+01
10.00	874.73	.685814E+00
15.00	878.27	.388483E-01
20.00	878.47	.181069E-02
25.00	878.48	.843950E-04
30.00	878.48	.393358E-05
35.00	878.48	.183343E-06
40.00	878.48	.854846E-08
45.00	878.48	.401334E-09
50.00	878.48	.210978E-10

TEMPERATURE HISTORY FOR BODY ELEMENT NUMBER 7

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.149051E+03
.50	251.93	.114195E+03
1.00	398.73	.874773E+02
1.50	511.18	.670002E+02
2.00	597.30	.513084E+02
3.00	710.39	.306885E+02
4.00	780.74	.178510E+02
5.00	821.65	.103806E+02
6.00	845.44	.603543E+01
8.00	867.02	.209387E+01
10.00	874.73	.685814E+00
15.00	878.27	.388483E-01
20.00	878.47	.181069E-02
25.00	878.48	.843950E-04
30.00	878.48	.393358E-05

35.00	878.48	.183344E-06
40.00	878.48	.854794E-08
45.00	878.48	.400814E-09
50.00	878.46	.205773E-10

TEMPERATURE HISTORY FOR BODY ELEMENT NUMBER 8

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.149250E+03
.50	252.18	.114336E+03
1.00	399.16	.875779E+02
1.50	511.73	.670711E+02
2.00	597.94	.513581E+02
3.00	711.12	.307127E+02
4.00	781.52	.178617E+02
5.00	822.46	.103849E+02
6.00	846.26	.603675E+01
8.00	867.84	.209353[illegible]+01
10.00	875.54	.685425E+00
15.00	879.08	.387819E-01
20.00	879.28	.180538E-02
25.00	879.29	.840443E-04
30.00	879.29	.391244E-05
35.00	879.29	.182134E-06
40.00	879.29	.848178E-08
45.00	879.29	.397039E-09
50.00	879.29	.206644E-10

TEMPERATURE HISTORY FOR BODY ELEMENT NUMBER 9

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.149051E+03
.50	251.93	.114195E+03
1.00	398.73	.874773E+02
1.50	511.18	.670002E+02
2.00	597.30	.513084E+02
3.00	710.39	.306885E+02
4.00	780.74	.178510E+02
5.00	821.65	.103806E+02
6.00	845.44	.603543E+01
8.00	867.02	.209387E+01
10.00	874.73	.685814E+00
15.00	878.27	.388483E-01
20.00	878.47	.181069E-02
25.00	878.48	.843950E-04
30.00	878.48	.393358E-05
35.00	878.48	.183343E-06
40.00	878.48	.854814E-08
45.00	878.48	.401018E-09
50.00	878.48	.207852E-10

TEMPERATURE HISTORY FOR BODY ELEMENT NUMBER 10

C03

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.149051E+03
.50	251.93	.114195E+03
1.00	398.73	.874773E+02
1.50	511.18	.670002E+02
2.00	597.30	.513084E+02
3.00	710.39	.306885E+02
4.00	780.74	.178510E+02
5.00	821.65	.103806E+02
6.00	845.44	.603543E+01
8.00	867.02	.209387E+01
10.00	874.73	.685814E+00
15.00	878.27	.388483E-01
20.00	878.47	.181069E-02
25.00	878.48	.843950E-04
30.00	878.48	.393358E-05
35.00	878.48	.183344E-06
40.00	878.48	.854741E-08
45.00	878.48	.400279E-09
50.00	878.48	.213749E-10

TEMPERATURE HISTORY FOR BODY ELEMENT NUMBER 11

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.149250E+03
.50	252.18	.114336E+03
1.00	399.16	.875779E+02
1.50	511.73	.670711E+02
2.00	597.94	.513581E+02
3.00	711.12	.307127E+02
4.00	781.52	.178617E+02
5.00	822.46	.103849E+02
6.00	846.26	.603675E+01
8.00	867.84	.209353E+01
10.00	875.54	.685425E+00
15.00	879.08	.387819E-01
20.00	879.28	.180538E-02
25.00	879.29	.840443E-04
30.00	879.29	.391244E-05
35.00	879.29	.182135E-06
40.00	879.29	.848149E-08
45.00	879.29	.396742E-09
50.00	879.29	.203695E-10

E03

BODY EQUILIBRIUM TEMPERATURE DISTRIBUTION

ELEMENT NUMBER	EQUILIBRIUM TEMPERATURE (DEG F)	ELEMENT NUMBER	EQUILIBRIUM TEMPERATURE (DEG F)	ELEMENT NUMBER	EQUILIBRIUM TEMPERATURE (DEG F)	ELEMENT NUMBER	EQUILIBRIUM TEMPERATURE (DEG F)
1	878.48	2	879.29	3	878.48	4	878.48
5	879.29	6	878.48	7	878.48	8	879.29
9	878.48	10	878.48	11	879.29		

F03 F03

BODY HEATING RATE INFORMATION
(COLD WALL HEAT FLUXES BASED ON 80 DEG F WALL TEMPERATURE)

ELEMENT NUMBER	RUNNING LENGTH (FEET)	REYNOLDS NUMBER	HEAT TRANSFER COEFFICIENT (BTU/FT2-SEC-DEG F)	COLD WALL HEAT FLUX (BTU/FT2-SEC)
1	.26867E+00	.42936E+08	.18181E+00	.14548E+03
2	.26867E+00	.42946E+08	.18187E+00	.14568E+03
3	.26867E+00	.42936E+08	.18181E+00	.14548E+03
4	.26867E+00	.42936E+08	.18181E+00	.14548E+03
5	.26867E+00	.42946E+08	.18187E+00	.14568E+03
6	.26867E+00	.42936E+08	.18181E+00	.14548E+03
7	.26867E+00	.42936E+08	.18181E+00	.14548E+03
8	.26867E+00	.42946E+08	.18187E+00	.14568E+03
9	.26867E+00	.42936E+08	.18181E+00	.14548E+03
10	.26867E+00	.42936E+08	.18181E+00	.14548E+03
11	.26867E+00	.42946E+08	.18187E+00	.14568E+03

TEMPERATURE HISTORIES FOR WING ELEMENTS

TEMPERATURE HISTORY FOR UPPER WING ELEMENT NUMBER 400

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.789899E+02
.50	214.40	.621622E+02
1.00	335.65	.489042E+02
1.50	431.02	.384608E+02
2.00	506.02	.302373E+02
3.00	608.08	.190262E+02
4.00	674.93	.116684E+02
5.00	715.92	.715101E+01
6.00	741.03	.438049E+01
8.00	765.44	.168620E+01
10.00	775.13	.616126E+00
15.00	780.27	.474068E-01
20.00	780.67	.306737E-02
25.00	780.70	.198466E-03
30.00	780.70	.128412E-04
35.00	780.70	.830857E-06
40.00	780.70	.537602E-07
45.00	780.70	.347980E-08
50.00	780.70	.226986E-09

TEMPERATURE HISTORY FOR UPPER WING ELEMENT NUMBER 401

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.658788E+02
.50	191.07	.539666E+02
1.00	298.17	.441972E+02
1.50	385.88	.361863E+02
2.00	457.68	.296189E+02
3.00	560.95	.201552E+02
4.00	634.22	.134249E+02
5.00	683.02	.893541E+01
6.00	715.48	.594409E+01
8.00	750.71	.269481E+01
10.00	767.23	.116992E+01
15.00	778.33	.144056E+00
20.00	779.73	.154145E-01
25.00	779.88	.164933E-02
30.00	779.89	.176475E-03
35.00	779.89	.188824E-04
40.00	779.89	.202037E-05
45.00	779.89	.216177E-06
50.00	779.89	.231316E-07

TEMPERATURE HISTORY FOR UPPER WING ELEMENT NUMBER 402

TIME	TEMPERATURE	HEAT FLUX

A04

(SECONDS)	(DEG F)	(BTU/FT2-SEC)
0.00	60.31	.591163E+02
.50	178.70	.494363E+02
1.00	277.70	.413322E+02
1.50	360.46	.345481E+02
2.00	429.63	.288702E+02
3.00	531.99	.204509E+02
4.00	607.68	.142113E+02
5.00	660.25	.986822E+01
6.00	696.75	.684854E+01
8.00	738.67	.337510E+01
10.00	760.07	.159986E+01
15.00	776.34	.248919E+00
20.00	778.93	.341989E-01
25.00	779.28	.469810E-02
30.00	779.33	.645394E-03
35.00	779.34	.886598E-04
40.00	779.34	.121795E-04
45.00	779.34	.167313E-05
50.00	779.34	.229845E-06

TEMPERATURE HISTORY FOR UPPER WING ELEMENT NUMBER 403

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.556014E+02
.50	172.18	.469974E+02
1.00	266.74	.397167E+02
1.50	346.64	.335562E+02
2.00	414.13	.283445E+02
3.00	515.52	.205008E+02
4.00	592.09	.145623E+02
5.00	646.46	.103365E+02
6.00	685.05	.733280E+01
8.00	730.70	.377308E+01
10.00	755.05	.187161E+01
15.00	774.80	.328148E+00
20.00	778.34	.512158E-01
25.00	778.89	.799235E-02
30.00	778.98	.124720E-02
35.00	778.99	.194623E-03
40.00	779.00	.303705E-04
45.00	779.00	.473927E-05
50.00	779.00	.739556E-06

TEMPERATURE HISTORY FOR UPPER WING ELEMENT NUMBER 404

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.532807E+02
.50	167.85	.453550E+02
1.00	259.38	.386008E+02
1.50	337.27	.328452E+02
2.00	403.54	.279414E+02
3.00	504.07	.204844E+02

4.00	581.06	.147658E+02
5.00	636.53	.106339E+02
6.00	676.47	.765577E+01
8.00	724.66	.405170E+01
10.00	751.12	.207081E+01
15.00	773.51	.392565E+00
20.00	777.86	.665940E-01
25.00	778.60	.112948E-01
30.00	778.72	.191562E-02
35.00	778.74	.324890E-03
40.00	778.75	.551015E-04
45.00	778.75	.934524E-05
50.00	778.75	.158496E-05

TEMPERATURE HISTORY FOR LOWER WING ELEMENT NUMBER 400

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.789899E+02
.50	214.40	.621622E+02
1.00	335.65	.489042E+02
1.50	431.02	.384608E+02
2.00	506.02	.302373E+02
3.00	608.08	.190262E+02
4.00	674.93	.116684E+02
5.00	715.92	.715101E+01
6.00	741.03	.438049E+01
8.00	765.44	.168620E+01
10.00	775.13	.616126E+00
15.00	780.27	.474068E-01
20.00	780.67	.306737E-02
25.00	780.70	.198466E-03
30.00	780.70	.128412E-04
35.00	780.70	.830857E-06
40.00	780.70	.537602E-07
45.00	780.70	.347980E-08
50.00	780.70	.226986E-09

TEMPERATURE HISTORY FOR LOWER WING ELEMENT NUMBER 401

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.658788E+02
.50	191.07	.539666E+02
1.00	298.17	.441972E+02
1.50	385.88	.361863E+02
2.00	457.68	.296189E+02
3.00	560.95	.201552E+02
4.00	634.22	.134249E+02
5.00	683.02	.893541E+01
6.00	715.48	.594409E+01
8.00	750.71	.269481E+01
10.00	767.23	.116992E+01
15.00	778.33	.144056E+00
20.00	779.73	.154145E-01
25.00	779.88	.164933E-02
30.00	779.89	.176475E-03

35.00	779.89	.188824E-04
40.00	779.89	.202037E-05
45.00	779.89	.216177E-06
50.00	779.89	.231316E-07

TEMPERATURE HISTORY FOR LOWER WING ELEMENT NUMBER 402

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.591163E+02
.50	178.70	.694363E+02
1.00	277.70	.413322E+02
1.50	360.46	.345481E+02
2.00	429.63	.288702E+02
3.00	531.99	.204509E+02
4.00	607.68	.142113E+02
5.00	660.25	.986822E+01
6.00	696.75	.684854E+01
8.00	738.67	.337510E+01
10.00	760.07	.159986E+01
15.00	776.34	.248919E+00
20.00	778.93	.341989E-01
25.00	779.28	.469810E-02
30.00	779.33	.645394E-03
35.00	779.34	.886598E-04
40.00	779.34	.121795E-04
45.00	779.34	.167313E-05
50.00	779.34	.229845E-06

TEMPERATURE HISTORY FOR LOWER WING ELEMENT NUMBER 403

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.556014E+02
.50	172.18	.465974E+02
1.00	266.74	.397167E+02
1.50	346.64	.335562E+02
2.00	414.13	.283445E+02
3.00	515.52	.205008E+02
4.00	592.09	.145623E+02
5.00	646.46	.103365E+02
6.00	685.05	.733280E+01
8.00	730.70	.377308E+01
10.00	755.05	.187161E+01
15.00	774.80	.328148E+00
20.00	778.34	.512158E-01
25.00	778.89	.799235E-02
30.00	778.98	.124720E-02
35.00	778.99	.194623E-03
40.00	779.00	.303705E-04
45.00	779.00	.473927E-05
50.00	779.00	.739556E-06

TEMPERATURE HISTORY FOR LOWER WING ELEMENT NUMBER 404

D04

D04

TIME (SECONDS)	TEMPERATURE (DEG F)	HEAT FLUX (BTU/FT2-SEC)
0.00	60.31	.532807E+02
.50	167.85	.453550E+02
1.00	259.38	.386008E+02
1.50	337.27	.328452E+02
2.00	403.54	.279414E+02
3.00	504.07	.204884E+02
4.00	581.06	.147658E+02
5.00	636.53	.106339E+02
6.00	676.47	.765377E+01
8.00	724.66	.405170E+01
10.00	751.12	.207081E+01
15.00	773.51	.392565E+00
20.00	777.86	.665940E-01
25.00	778.60	.112948E-01
30.00	778.72	.191562E-02
35.00	778.74	.324890E-03
40.00	778.75	.551015E-04
45.00	778.75	.934524E-05
50.00	778.75	.158496E-05

E04

UPPER WING EQUILIBRIUM TEMPERATURE DISTRIBUTION

ELEMENT NUMBER	EQUILIBRIUM TEMPERATURE (DEG F)	ELEMENT NUMBER	EQUILIBRIUM TEMPERATURE (DEG F)	ELEMENT NUMBER	EQUILIBRIUM TEMPERATURE (DEG F)	ELEMENT NUMBER	EQUILIBRIUM TEMPERATURE (DEG F)
400	780.70	401	779.89	402	779.34	403	779.00
404	778.75						

UPPER WING HEATING RATE INFORMATION
(COLD WALL HEAT FLUXES BASED ON 80 DEG F WALL TEMPERATURE)

ELEMENT NUMBER	RUNNING LENGTH (FEET)	REYNOLDS NUMBER	HEAT TRANSFER COEFFICIENT (BTU/FT2-SEC-DEG F)	COLD WALL HEAT FLUX (BTU/FT2-SEC)
400	.23417E+00	.28583E+08	.10904E+00	.76857E+02
401	.70248E+00	.85748E+08	.90946E-01	.64102E+02
402	.14051E+01	.17152E+09	.81612E-01	.57523E+02
403	.21076E+01	.25726E+09	.76761E-01	.54104E+02
404	.28102E+01	.34302E+09	.73558E-01	.51846E+02

LOWER WING EQUILIBRIUM TEMPERATURE DISTRIBUTION

ELEMENT NUMBER	EQUILIBRIUM TEMPERATURE (DEG F)	ELEMENT NUMBER	EQUILIBRIUM TEMPERATURE (DEG F)	ELEMENT NUMBER	EQUILIBRIUM TEMPERATURE (DEG F)	ELEMENT NUMBER	EQUILIBRIUM TEMPERATURE (DEG F)
400	780.70	401	779.89	402	779.34	403	779.00
404	778.75						

A05 A05

LOWER WING HEATING RATE INFORMATION
(COLD WALL HEAT FLUXES BASED ON 80 DEG F WALL TEMPERATURE)

ELEMENT NUMBER	RUNNING LENGTH (FEET)	REYNOLDS NUMBER	HEAT TRANSFER COEFFICIENT (BTU/FT2-SEC-DEG F)	COLD WALL HEAT FLUX (BTU/FT2-SEC)
400	.23417E+00	.28583E+08	.10904E+00	.76857E+02
401	.70248E+00	.85748E+08	.90946E-01	.64102E+02
402	.14051E+01	.17152E+09	.81612E-01	.57523E+02
403	.21076E+01	.25726E+09	.76761E-01	.54104E+02
404	.28102E+01	.34302E+09	.73558E-01	.51846E+02

.........END OF COMPUTATIONS ....

6.2.2 Blunted Nose Pressure Distribution

```
A01SAMPLE INPUT FOR SLIGHTLY BLUNTED NOSE OGIVE                               A01
```

```
 E01                                                                                              E01
SUNIFID

ICASE   = 2,

NTRANS  = 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,

IPUNCH  = 0,

IFW     = 0,

POLAR   = 0.0,

ISOLID  = 0,

SID     = .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,      .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,
          .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,

NBPFL   = 20,

XB      = 0.0, .2E+00, .261E+00, .35E+00, .439E+00, .529E+00, .619E+00,      .711E+00, .108E+01, .1551E+01, .203E+01,
          .2415E+01, .2512E+01, .2647E+01, .2936E+01, .3423E+01, .3613E+01,     .3898E+01, .4366E+01, .4826E+01, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

RB      = 0.0, .928E-01, .1247E+00, .1632E+00, .2002E+00, .2356E+00, .269E+00,   .302E+00, .415E+00, .519E+00, .582E+00,
          .602E+00, .603E+00, .6015E+00, .587E+00, .527E+00, .492E+00,          .427E+00, .283E+00, .962E-01, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

ZD      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

RP      = 0.0,

NWPI    = 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,

YAW     = 0.0,

BROLL   = 0.0,

NWING   = 0,

IFORM   = 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,

PIVOT   = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

THICK   = .1E+01,

DIHED   = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

XWI     = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
```

C01   C01

```
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
YM1 = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
ZM1 = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
```

```
D01                                                                                                D01
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
XNACEL   = 0.0,
NACELP   = 0,
XN       = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
RN       = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
ZN       = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
NWPANL   = 0,
XLG      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
XTG      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
XMACH    = .2E+01,
PINF     = .147E+02,
DADEG    = 0.0,
ARB      = 0.0,
ARW      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
IHTRANF  = 0,
INOSE    = 1,
RNOSE    = .935E-01,
TI       = .518E+03,
BMATL    = 0.0,
BSPHT    = 0.0,
BDENS    = 0.0,
BTHICK   = 0.0,
```

```
E01
BEPS   = 0.0,
WMATL  = 0.0,
WSPHT  = 0.0,
WDENS  = 0.0,
WTHICK = 0.0,
WEPS   = 0.0,
TEMPI  = 0.0,
$END

DESCRIPTION OF CASE REQUESTED

SYMMETRICAL CONFIGURATION - PANELS LOCATED ON BOTH SIDES OF X-Z PLANE(SYM = 1.)
CASE = 2.        CALCULATE CL, GIVEN SHAPE
CPCALC = 1.      NON-LINEAR CP
POLAR = 1.       POLARS REQUESTED
THICK = 0.       WING THICKNESS PRESSURES NOT TO BE ADDED
VOUT = 0.        VELOCITY COMPONENTS NOT TO BE PRINTED
MACH NUMBER =   2.0000
POINT ABOUT WHICH THE MOMENTS ARE TO BE COMPUTED
 X-COORDINATE =    0.0000
 Z-COORDINATE =    0.0000
REFERENCE CHORD LENGTH =    1.0000
WING REFERENCE AREA =    1.0000
WING SEMI-SPAN =    1.0000
BODY REFERENCE AREA  =     1.1389
HEIGHT OF WING PLANE ABOVE BODY AXIS =    0.0000
INCLINATION OF BODY AXIS WITH RESPECT TO DEFINING AXIS =    0.0000  DEG.
ANGLE OF ATTACK WITH RESPECT TO BODY AXIS =    0.0000  DEG.
BODY YAW =      0.00 DEG
BODY ROLL =      0.00 DEG
```

F01 F01

PRESSURES, FORCES AND MOMENTS ON BODY

CD = .2420 CL = -.0290 CB = 0.0000 CPM = .0892 CRM = 0.0000 CYM = -1.0742

BODY PRESSURE COEFFICIENTS (CP)

THETA (DEG.) X	0.00	30.00	60.00	90.00	120.00	150.00	180.00
0.0000	.3439	.3439	.3439	.3439	.3439	.3439	.3439
.0965	.3801	.3801	.3801	.3801	.3801	.3801	.3801
.1930	.4163	.4163	.4163	.4163	.4163	.4163	.4163
.2896	.3517	.3517	.3517	.3517	.3517	.3517	.3517
.3861	.3398	.3398	.3398	.3398	.3398	.3398	.3398
.4826	.3125	.3125	.3125	.3125	.3125	.3125	.3125
.5791	.2959	.2959	.2959	.2959	.2959	.2959	.2959
.6756	.2778	.2778	.2778	.2778	.2778	.2778	.2778
.7722	.2559	.2559	.2559	.2559	.2559	.2559	.2559
.8687	.2349	.2349	.2349	.2349	.2349	.2349	.2349
.9652	.2009	.2009	.2009	.2009	.2009	.2009	.2009
1.2410	.1500	.1500	.1500	.1500	.1500	.1500	.1500
1.5167	.1034	.1034	.1034	.1034	.1034	.1034	.1034
1.7925	.0500	.0500	.0500	.0500	.0500	.0500	.0500
2.0683	.0046	.0046	.0046	.0046	.0046	.0046	.0046
2.3441	-.0402	-.0402	-.0402	-.0402	-.0402	-.0402	-.0402
2.6198	-.0883	-.0883	-.0883	-.0883	-.0883	-.0883	-.0883
2.8956	-.1345	-.1345	-.1345	-.1345	-.1345	-.1345	-.1345
3.1714	-.1867	-.1867	-.1867	-.1867	-.1867	-.1867	-.1867
3.4471	-.2238	-.2238	-.2238	-.2238	-.2238	-.2238	-.2238
3.7229	-.2681	-.2681	-.2681	-.2681	-.2681	-.2681	-.2681
3.9987	-.3104	-.3104	-.3104	-.3104	-.3104	-.3104	-.3104
4.2745	-.3081	-.3081	-.3081	-.3081	-.3081	-.3081	-.3081
4.5502	-.2115	-.2115	-.2115	-.2115	-.2115	-.2115	-.2115
4.8260	1.0281	1.0281	1.0281	1.0281	1.0281	1.0281	1.0281

TOTAL DRAG COEFFICIENT - INCLUDING SPHERICAL NOSE CD = .4675

BODY PRESSURE COEFFICIENTS (CP), INCLUDING THE EFFECT OF SLIGHTLY BLUNTED NOSE

THETA (DEG) X	0.0000	30.0000	60.0000	90.0000	120.0000	150.0000	180.0000
0.0000	1.65730	1.65730	1.65730	1.65730	1.65730	1.65730	1.65730
.0007	1.63092	1.63092	1.63092	1.63092	1.63092	1.63092	1.63092
.0030	1.55346	1.55346	1.55346	1.55346	1.55346	1.55346	1.55346
.0067	1.42984	1.42984	1.42984	1.42984	1.42984	1.42984	1.42984
.0117	1.26795	1.26795	1.26795	1.26795	1.26795	1.26795	1.26795
.0181	1.07809	1.07809	1.07809	1.07809	1.07809	1.07809	1.07809
.0257	.87235	.87235	.87235	.87235	.87235	.87235	.87235
.0343	.66382	.66382	.66382	.66382	.66382	.66382	.66382
.0439	.46579	.46579	.46579	.46579	.46579	.46579	.46579
.0543	.29086	.29086	.29086	.29086	.29086	.29086	.29086
.0935	.34387	.34387	.34387	.34387	.34387	.34387	.34387
.0965	.38008	.38008	.38008	.38008	.38008	.38008	.38008
.1930	.41628	.41628	.41628	.41628	.41628	.41628	.41628
.2896	.35173	.35173	.35173	.35173	.35173	.35173	.35173
.3861	.33983	.33983	.33983	.33983	.33983	.33983	.33983
.4826	.31245	.31245	.31245	.31245	.31245	.31245	.31245
.5791	.29592	.29592	.29592	.29592	.29592	.29592	.29592
.6756	.27782	.27782	.27782	.27782	.27782	.27782	.27782
.7722	.25586	.25586	.25586	.25586	.25586	.25586	.25586

G01 G01

.8687	.23492	.23492	.23492	.23492	.23492	.23492	.23492
.9652	.20093	.20093	.20093	.20093	.20093	.20093	.20093
1.2410	.14998	.14998	.14998	.14998	.14998	.14998	.14998
1.5167	.10337	.10337	.10337	.10337	.10337	.10337	.10337
1.7925	.04997	.04997	.04997	.04997	.04997	.04997	.04997
2.0683	.00459	.00459	.00459	.00459	.00459	.0045[illegible]	.00459
2.3441	-.04016	-.04016	-.04016	-.04016	-.04016	-.04016	-.04016
2.6198	-.08833	-.08833	-.08833	-.08833	-.08833	-.08833	-.08833
2.8956	-.13449	-.13449	-.13449	-.13449	-.13449	-.13449	-.13449
3.1714	-.18671	-.18671	-.18671	-.18671	-.18671	-.18671	-.18671
3.4471	-.22381	-.22381	-.22381	-.22381	-.22381	-.22381	-.22381
3.7229	-.26809	-.26809	-.26809	-.26809	-.26809	-.26809	-.26809
3.9987	-.31040	-.31040	-.31040	-.31040	-.31040	-.31040	-.31040
4.2745	-.30809	-.30809	-.30809	-.30809	-.30809	-.30809	-.30809
4.5502	-.21154	-.21154	-.21154	-.21154	-.21154	-.21154	-.21154
4.8260	1.02814	1.02814	1.02814	1.02814	1.02814	1.02814	1.02814

AERODYNAMIC PRESSURE ON THE BODY - - CENTROID OF FINITE ELEMENT AS GENERATED BY NSWC CODE IN THE SAME LOCAL COORDINATE SYSTEM

ELEMENT	X	THETA	PRESSURE	TEMP R	MACH NO.
1	.269E+00	.345E+03	.168E+02	0.000	0.000
2	.269E+00	.315E+03	.159E+02	0.000	0.000
3	.269E+00	.285E+03	.168E+02	0.000	0.000
4	.269E+00	.255E+03	.168E+02	0.000	0.000
5	.269E+00	.225E+03	.159E+02	0.000	0.000
6	.269E+00	.195E+03	.168E+02	0.000	0.000
7	.269E+00	.165E+03	.168E+02	0.000	0.000
8	.269E+00	.135E+03	.159E+02	0.000	0.000
9	.269E+00	.105E+03	.168E+02	0.000	0.000
10	.269E+00	.750E+02	.168E+02	0.000	0.000
11	.269E+00	.450E+02	.159E+02	0.000	0.000
12	.269E+00	.150E+02	.168E+02	0.000	0.000
21	.180E-01	.345E+03	.444E+02	0.000	0.000
22	.180E-01	.315E+03	.444E+02	0.000	0.000
23	.180E-01	.285E+03	.444E+02	0.000	0.000
24	.180E-01	.255E+03	.444E+02	0.000	0.000
25	.180E-01	.225E+03	.444E+02	0.000	0.000

.........END OF COMPUTATIONS ....

Section 7

CONCLUSIONS AND RECOMMENDATIONS

The MDAC/NSWC aerodynamic code has been extended to treat (a) aerodynamic heating at high supersonic speeds and (b) nose pressure of a missile with a slightly blunted nose. The input modifications have been kept to a minimum. In the aerodynamic heating case, only a few of the appropriate material properties are required with the default values set for aluminum. Only two new inputs are necessary for the blunt nose case.

As developed, the code represents a unique and versatile tool with missile analysis capability that is paramount to design studies. The advantage of the output generation options available, in the form of NASTRAN input specifications for stress analysis, needs no explanation. Additionally, the small computing effort required for each case, must encourage its use.

When analyzing the operational capability of a missile, often times only a few selected points on its planned trajectory are used for study and evaluation. With the advent of the cruise missile, considerable variation in the flight environment may be encountered. To provide assessment of its performance under this situation, many cases must be analyzed. For this purpose, a flexible restart capability that can meet all the changes required for every case while eliminating unnecessary computational duplication will be most welcome. The present code is well suited for modification to this end.

REFERENCES

1. K. K. Wang, "Aerodynamic Computer Code for Computing Pressure Loads on a Missile at High Supersonic Speeds and Generalized Attitudes", Report No. MDC G8223, McDonnell Douglas Astronautics Company, Huntington Beach, California, November 1979.

2. P. C. Huang and J. P. Matra, Jr., "Planform Input Generator (PING), A NASTRAN Preprocessor for Lifting Surface-Theoretical Development, User's Manual, and Program Listing", NOLTR-73-199, Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland, December 1973.

3. P. C. Huang and J. P. Matra, Jr., "Missile Body Input Generator (BING), A NASTRAN Preprocessor; Theoretical Development, User's Manual and Program Listing, NSWC-NOL-TR-75-9, Naval Surface Weapons Center, White Oak, Silver Spring, Maryland, March 1975.

4. E. R. G. Eckert, "Survey on Heat Transfer at High Speeds", Wright Air Development Center report WADC TR 54-70, dated April 1954, reissued as Aeronautical Research Laboratory report ARL 189, dated December 1961.

5. E. R. G. Eckert, "Engineering Relations for Heat Transfer and Friction in High-Velocity Laminar and Turbulent Boundary-Layer Flow Over Surfaces with Constant Pressure and Temperature", Transactions of the ASME, Vol. 78, No. 8, pp. 1273-1283, August 1956.

6. E. R. G. Eckert, "Survey of Boundary Layer Heat Transfer at High Velocities and High Temperatures", Wright Air Development Center report WADC TR 59-624, dated April 1960.

7. Robert E. Wilson, "Turbulent Boundary-Layer Characteristics of Supersonic Speeds - Theory and Experiment", Journal of the Aeronautical Sciences, Vol. 17, No. 9, pp. 585-594, September 1950.

8. E. R. Van Driest, "Investigation of Laminar Boundary Layer in Compressible Fluids Using the Crocco Method", NACA TN2597, January 1952.

9. E. R. Van Driest, "Turbulent Boundary Layer in Compressible Fluids", Journal of the Aeronautical Sciences, Vol. 18, No. 3, pp. 145-160 and 216, March 1951.

10. E. R. Van Driest, "The Problem of Aerodynamic Heating", Aeronautical Engineering Review, pp. 26-41, October 1956.

11. D. B. Spalding and S. W. Chi, "The Drag of a Compressible Turbulent Boundary Layer on a Smooth Flat Plate With and Without Heat Transfer", Journal of Fluid Mechanics, Vol. 18, Part 1, pp. 117-143, January 1964.

12. L. Lees, "Hypersonic Flow", Inst. Aero. Science Preprint No. 554, 1955.

13. L. K. Isaacson and J. W. Jones, "Prediction Techniques for Pressure and Heat-Transfer Distributions Over Bodies of Revolution in High-Subsonic to Low-Supersonic Flight", NWC-TP-4570, Naval Weapons Center, China Lake, CA, November 1968.

14. Donald M. Wilson, "Measurements of Hypersonic Turbulent Heat Transfer on a Highly Cooled Cone", U.S. Naval Ordnance Laboratory, White Oak, Maryland, NOLTR 67-24, 17 July 1967.

15. A. O. Pearson, "Surface Pressure Distribution on 0.0628-Scale Models of Proposed Project Fire Space Vehicle at Mach Numbers From 0.25 to 4.63", NASA TN D-1961, Washington, DC, September 1963.

16. K. Okanchi, "Summary of Results of Pressure Coefficient Calculations for a Spherically Tipped Tangent-Ogive Body", Naval Ordnance Test Station, NOTS TP 3050, October 1962.

17. W. R. Sears (Editor), General Theory of High Speed Aerodynamics, Volume II High Speed Aerodynamics and Jet Propulsion, Princeton University Press, 1954, pp. 352-7.

18. J. S. Andrews, "Steady State Airload Distribution on Hammerhead Shaped Payload of a Multistaged Vehicle at Transonic Speeds", Boeing Company, D2-22947-1, Seattle, Washington, January, 1964.

DISTRIBUTION LIST

For CDRL Item A002
Users Manual - Computer Program

	Copies
NAVY	
Naval Surface Weapons Center White Oak Laboratory Silver Spring, Maryland 20910	
G40	1
G402 (Huang)	10
G402 (Matra)	6
R14 (Kiddy)	1
K82 (Edwards)	1
X21	3
S10	1
S20	1
Naval Surface Weapons Center Dahlgren Laboratory Dahlgren, Virginia 22448	
K21 (Blackburn)	1
G04 (Soper)	1
K21	1
Office of Chief of Naval Operations Operations Evaluation Group (OP-13EG) Washington, D.C. 20350	1
Defense Nuclear Agency Washington, D.C. 20301	2
Defense Documentation Center Cameron Station Alexandria, Virginia 22314	12
Commander Naval Sea Systems Command Washington, D.C. 20360	
SEA-03A	1
SEA-0333	1
SEA-035-13	12
SEA-035A	1
SEA-55212	1
SEA-0632	2
SEA-654312	1
PMS-403-02	1
Commander Naval Air Systems Command (AIR-320-B) Washington, D.C. 20360	1

	Copies
Commander	
Pacific Missile Test Center	
Point Mugu, California 93042	
T.W. Elliott (Code 5331)	1
Commander	
Naval Air Development Center	
Johnsville, Warminster, Pennsylvania 18974	
Dr. E. McQuillan (Code 3033)	1
Herman Rubin (Code 3033)	1
K.T. Yen (Code 30331)	1
Naval Research Laboratory	
Washington, D.C. 20390	
Dr. M.R. Achter (Code 6340)	1
Commander	
Naval Weapons Center	
China Lake, California 93557	
Code 4062	1
Code 45703	1
Mr. E.L. Jeter	1
James E. Serpanos	1
Ken Miller (Code 3242)	1
Office of Naval Research	
Department of the Navy	
Washington, D.C. 20360	
Code 461	1
Code 439 (N. Perrone)	1
Code 470	1
Technical Library	2
Naval Postgraduate School	
Monterey, California 93940	
Code 2124	1
Dr. J.G. Cantin	1
Commanding Officer	
Naval Ship Research and Development Center	
Bethesda, Maryland 20034	
Code 1844 (Jim McKee)	1
Code 1844 (Gordon Everstine)	1
Code 564	2

	Copies
Air Force	
AFFDL/PTS (CAPT Gilbert L. Camburn) AF Flight Dynamics Laboratory Wright-Patterson Air Force Base, Ohio 45433	1
AF Materials Laboratory Wright-Patterson Air Force Base, Ohio 45433 Code MAAN (B.R. Emrich)	1
Flight Dynamics Laboratory Structures Division Wright-Patterson Air Force Base, Ohio 45433 Mr. Leo J.D. Bernier	1
AFML/LLM (W.G. Ramke) Wright Patterson Air Force Base, Ohio 45433	1
AFATL/DLRV Eglin Air Force Base, Florida 32542 James M. Heard	2
AFAL/TEM-3 Wright-Patterson Air Force Base, Ohio 45433 Richard A. Ireland	1
Army	
Commanding General U.S. Army Missile Command Redstone Arsenal, Alabama 35809	1
Industry	
Applied Physics Laboratory The Johns Hopkins University 8621 Georgia Avenue Silver Spring, Maryland 20910	
L.B. Weckesser	1
W.C. Caywood	1
R.M. Rivello	1

	Copies
Battelle Memorial Institute Defense Metals Information Center 505 King Avenue Columbus, Ohio 43201	
H.D. Moran	1
Brunswick Corporation Technical Products Division 325 Brunswick Lane Marion, Virginia 24354	
Robert Copeland	1
General Dynamics/Pomona P.O. Box 2507 Pomona, California 91766	
R.A. Miller	1
D.A. Underhill	1
Raytheon Company Missile Systmes Division, VB1-3 Hartwell Road Bedford, Massachusetts 01730	
R.D. Howe	1
D.H. Sanders	1
McDonnell Douglas Astronautics Co. 5301 Bolsa Avenue Huntington Beach, California 92647	
W.F. Bozich	1
K.K. Wang	1
R.S. Lee	1
McDonnell Douglas Astronautics Co. Eastern Division P.O. Box 516 St. Louis, Missouri 63166	
J. Gubser	1
Lockheed Missiles and Space Co. Dept 81-12, Building 154 Box 504 Sunnyvale, California 94088	
J.A. Bailie	1
Lockheed Missile and Space Co. Dept 52-30, Building 103 P.O. Box 504 Sunnyvale, California 94088	
Robert M. Beasley	1
Senior Staff Scientist	1

	Copies
Lockheed Missile and Space Co. Technical Information Center 3251 Hanover Street Palo Alto, California 94034	1
Hughes Aircraft Company Missile System Division Canoga Park, California 91340	
R.J. Oedy	1
Hughes Aircraft Company Culver City, California 90230	
L.E. GATES, M.S. H-164	1
The Boeing Company P.O. Box 3999 Seattle, Washington 98124	
R. Blaisdell	1
K. Brettmann	1
Martin-Marietta Corporation P.O. Box 5837 Orlando, Florida 32805	
G.H. Sprague, Jr. (Director Aeromechanical Division)	1
G. Fotieo	1
Honeywill, Incorporated 600 2nd Street North Hopkins, Minnesota 55343	
J.D. Brannan	1
Fairchild Republic Co. Farmingdale, New York 11735	
Jim Clarke	1
Mail Stop Z-19A-08	1
Raytheon Co. Spencer Lab Burlington, Massachusetts 01803	
Doris A. Holden	1
Dept 7113	1
TOTAL	110

FILMED

4-8